Large Filing Separator Sheet

Case Number: 12-1857-EL-RDR

File Date: 6/29/2012

Section: 10

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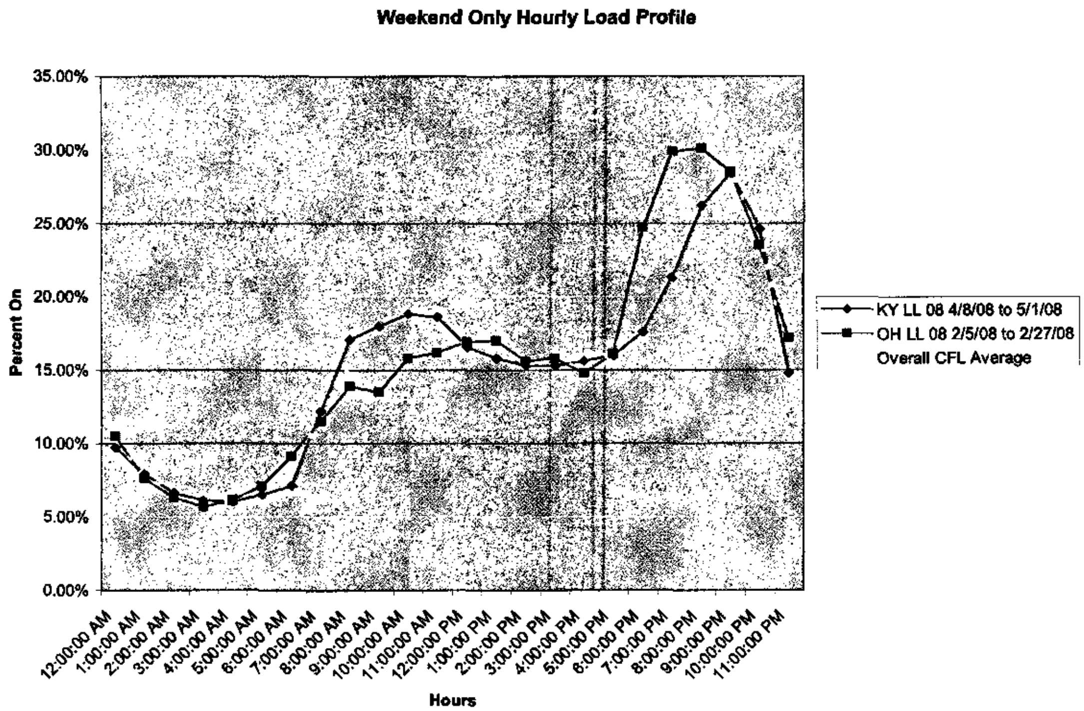
Description of Document: New Case


Weekend Only Hourly Load Profile
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Percent On
12:00:00 AM
1:00:00 AM
2:00:00 AM
3:00:00 AM
4:00:00 AM
5:00:00 AM
6:00:00 AM
7:00:00 AM
8:00:00 AM
9:00:00 AM
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6:00:00 PM
7:00:00 PM
8:00:00 PM
9:00:00 PM
10:00:00 PM
11:00:00 PM
Hours
KY LL 08 4/8/08 to 5/1/08
OH LL 08 2/5/08 to 2/27/08
Overall CFL Average

Appendix 5: Distributions of Initial and Final Populations

These findings are supported by a Kolmogorov-Smirnov Z test of the survey responses of the two logger study populations, which compared the responses of each population to similar questions on the surveys to determine whether the two populations are similar to one another, that is, come from similar distributions. Because participants self-select into the survey responses and logger studies, it is important to confirm that the samples are similar. The absolute, positive, and negative statistics display the largest differences between distributions in each sample. The "Asymp. Sig." values state whether this difference is significant. If the significance, or P values, are greater than .01, then we cannot reject the statement that the populations come from the same distribution.

Tables 7 and 8 show the first test, comparing the initial and final lighting logger study populations. The P values for this test are above .01, meaning that we cannot reject the statement that the populations come from the same distribution. P values for questions 8 through 11 are affected by the fact that the surveys were given before and after the implementation of the CFL program. Questions 8 through 11 also have the largest absolute difference values.

Table 7. K-S Z test for Initial and Final Lighting Logger Study Populations

		1	2	3	4	5	6	7	8
		What is the approximate square footage (heated area) of your home?	How many people live in your home?	Type of heating system?	Type of cooling system?	Primary heating fuel?	Primary cooling fuel?	Do you own or rent your home?	Do you recall receiving CFL bulb coupons from Duke Energy, for use in Wal-Mart GE bulbs?
Most Extreme Differences	Absolute	.249	.238	.108	.124	.084	.082	.341	.475
	Positive	.249	.238	.013	.124	.000	.082	.341	.475
	Negative	-.125	-.148	-.108	-.033	-.084	.000	.000	.000
Kolmogorov-Smirnov Z		1.104	1.101	.498	.578	.387	.379	1.590	2.197
Asymp. Sig. (2-tailed)		.175	.177	.965	.892	.998	.999	.013	.000

Table 8. K-S Z test for Initial and Final Lighting Logger Study Populations continued

		9	10	11	12	13	14	15	16	17	18
		How many CFL bulbs did you purchase in total?	How many CFL bulbs would you have bought without the coupon?	How many CFLs are now installed?	Did you change the hours of use since installing the CFLs?	How many of the CFLs you installed have you removed?	How many CFL bulbs have you since purchased without coupons?	Overall, how satisfied are you with the CFLs?	How many CFLs did you have in your house before you bought these discounted CFLS?	In what year was your home built?	How would you best describe the type of home in which you live?
Most Extreme Differences	Absolute	.970	.306	.716	.070	.229	.203	.241	.248	.243	.110
	Positive	.000	.000	.000	.070	.229	.000	.241	.031	.000	.110
	Negative	-.970	-.306	-.716	.000	.000	-.203	.000	-.248	-.243	-.091
Kolmogorov-Smirnov Z		4.211	1.253	2.869	.266	.650	.802	.889	.884	1.086	.504
Asymp. Sig. (2-tailed)		.000	.086	.000	1.000	.793	.540	.408	.416	.189	.961

Tables 9 and 10 show a K-S Z test comparing the entire survey population for each survey (not just the lighting logger participants). The results of this test show similar results to the first K-S Z test comparing the logger study participants only. Again, the P values are above .01, meaning we cannot reject the statement that the two populations are similar. The largest absolute differences between the populations are from questions 8 through 11.

Table 9. K-S Z test for Initial and Final CFL Program Survey Populations

		What is the approximate square footage (heated area) of your home?	How many people live in your home?	Type of heating system?	Type of cooling system?	Primary heating fuel?	Primary cooling fuel?	Do you own or rent your home?	Do you recall receiving CFL bulb coupons from Duke Energy, for use in Wal-Mart GE bulbs?
Most Extreme Differences	Absolute	.175	.207	.062	.108	.081	.106	.242	.470
	Positive	.175	.207	.062	.108	.029	.106	.242	.470
	Negative	-.063	-.094	-.018	-.029	-.081	.000	.000	.000
Kolmogorov-Smirnov Z		1.016	1.262	.379	.667	.493	.655	1.498	2.872
Asymp. Sig. (2-tailed)		.254	.083	.999	.765	.968	.784	.023	.000

Table 10. K-S Z test for Initial and Final CFL Program Survey Populations continued

		How many CFL bulbs did you purchase in total?	How many CFL bulbs would you have bought without the coupon?	How many CFLs are now installed?	Did you change the hours of use since installing the CFLs?	How many of the CFLs you installed have you removed?	How many CFL bulbs have you since purchased without coupons?	Overall, how satisfied are you with the CFLs?	How many CFLs did you have in your house before you bought these discounted CFLS?	In what year was your home built?	How would you best describe the type of home in which you live?
Most Extreme Differences	Absolute	.968	.324	.715	.073	.240	.261	.214	.169	.215	.145
	Positive	.000	.028	.000	.073	.240	.000	.214	.169	.000	.145
	Negative	-.968	-.324	-.715	.000	-.008	-.261	.000	-.144	-.215	-.023
Kolmogorov-Smirnov Z		5.402	1.643	3.499	.334	.753	1.251	.937	.706	1.282	.895
Asymp. Sig. (2-tailed)		.000	.009	.000	1.000	.622	.087	.343	.701	.075	.400

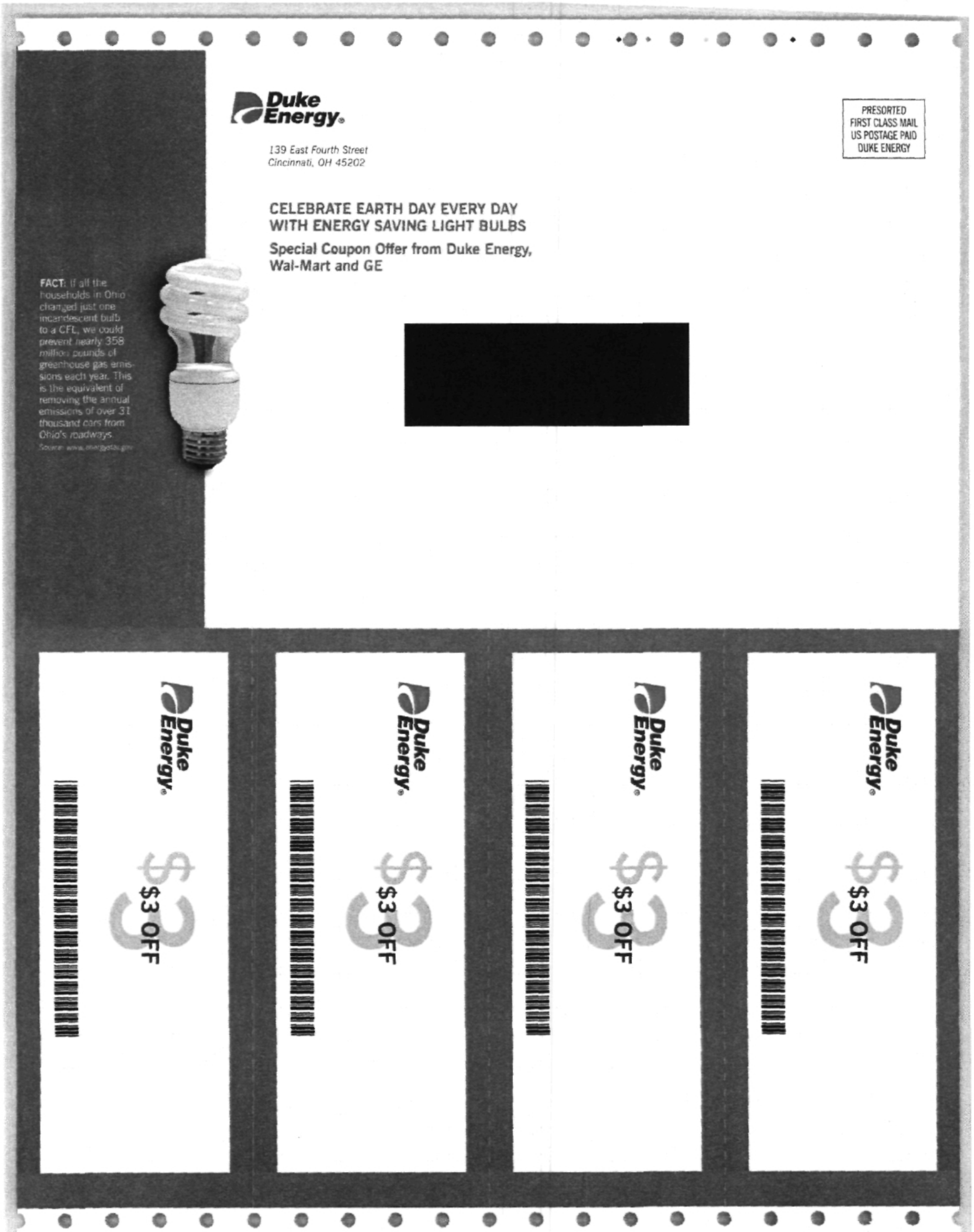
These findings are also supported by a K-S Z test of the lighting logger data for each population, which finds that we cannot reject the null hypothesis that the two populations come from the same distribution based on the p value greater than .05 (95% confidence).

Table 11. K-S Z test for Initial and Final Lighting Logger Study Populations

		average hours per day
Most Extreme Differences	Absolute	.135
	Positive	.026
	Negative	-.135
Kolmogorov-Smirnov Z		1.245
Asymp. Sig. (2-tailed)		.090

Appendix 6: Wal-Mart CFL Coupon Mailer

Black boxes mark placement of address labels and barcodes.



SAVE TODAY AND TOMORROW WITH ENERGY SAVING LIGHT BULBS.

Duke Energy Celebrates Earth Month with Wal-Mart and GE
Duke Energy is proud to offer our customers special savings on the purchase of GE Energy Smart™ compact fluorescent light bulbs (CFLs). Today's CFLs produce high-quality, soft white light, are smaller than the CFLs of the past, and can be used in a variety of fixtures.

Save Money on Energy...
Now That's a Bright Idea
When you use CFL bulbs throughout your home, your savings will quickly add up and you'll be helping to conserve valuable energy resources. When you purchase and install a 3-pack of CFLs, you will:

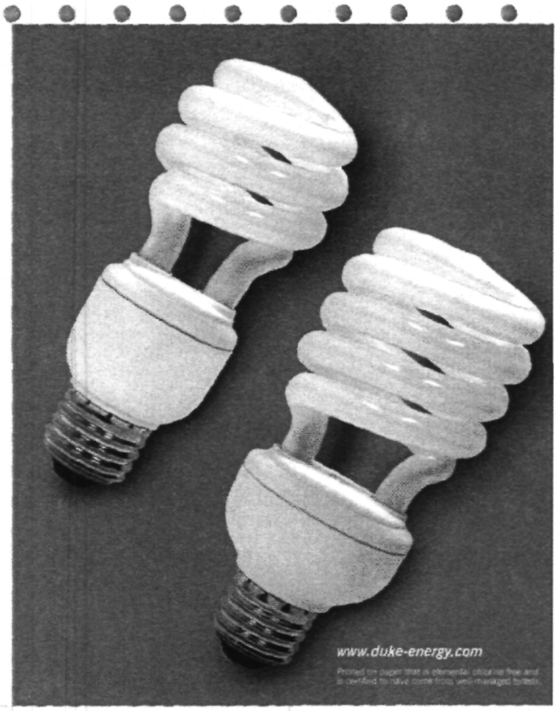
- Save $47 to $74 on energy bills over the rated life of each bulb
- Use up to 75% less energy
- Change bulbs less frequently because CFLs last up to 10 times longer

See package for specific product ratings. Energy savings based on 10¢ per kWh.

Experience Savings Now With These Valuable Coupons
Visit Wal-Mart today and select a three-pack of GE Energy Smart™ light bulbs and start saving.

Duke Energy · GE · WAL*MART

Duke Energy Ohio may offer additional energy saving programs to customers using these coupons.



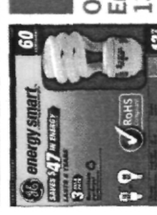
MANUFACTURER'S COUPON • EXPIRES 06.30.08

$3 OFF ONE GE Energy Smart™ 13 Watt CFL 3-Pack

Redeemable at Wal-Mart ONLY

[redacted]

MANUFACTURER'S COUPON • EXPIRES 06.30.08



$3 OFF ONE GE Energy Smart™ 13 Watt CFL 3-Pack

Redeemable at Wal-Mart ONLY

[redacted]

MANUFACTURER'S COUPON • EXPIRES 06.30.08

$3 OFF ONE GE Energy Smart™ 20 Watt CFL 3-Pack

Redeemable at Wal-Mart ONLY

[redacted]

MANUFACTURER'S COUPON • EXPIRES 06.30.08

$3 OFF ONE GE Energy Smart™ 26 Watt CFL 3-Pack

Redeemable at Wal-Mart ONLY

[redacted]

Appendix 7: CFL Program Interactions with Retailers

This is a chart of the interactions between the various campaigns and stores that a CFL promotion has occurred in so far (including and in addition to Wal-Mart).

A letter represents a distributor, and a number represents a subset of that distributor (web, other, mail, etc.).

Interactions	Number of customers
A1	275
B1	1683
B1 & A1	1
C1	326
C1 & A1	1
C1 & B1	9
D1 & B1	4573
D1 & A1	12
D1 & B1	47
D1 & C1	1
A2	101
A2 & B1	1
A2 & C1	2
A2 & D1	6
A3	36
A3 & B1	1
A3 & D1	1
A3 & A2 & D1	1
E1	6172
E1 & A1	27
E1 & B1	71
E1 & B1 & A1	2
E1 & C1	29
E1 & C1 & B1	3
E1 & D1	26
E1 & D1 & A1	2
E1 & D1 & B1	1
E1 & D1 & C1	2
D2	29528
D2 & A1	46
D2 & B1	162
D2 & B1 & A1	2
D2 & D1	120
D2 & A2	21
D2 & A3	10
D2 & E1	1870
D2 & E1 & A1	13

D2 & E1 & B1	28
D2 & E1 & B1 & A1	1
D2 & E1 & D1	27
D2 & E1 & D1 & B1	2
Total	45242

Appendix 8: Tables of Customer Characteristics Model Data

The following tables describe the customer characteristics that were appended to customer data for the Customer Characteristics model in Section 1. As previously stated, the model compared equal populations of CFL redeemers and other customers to determine the characteristics of customers more likely to participate in the promotion. The tables show the distribution of responses. In some cases, customer responses were grouped into ranges. Where applicable, the ranges are based on the characteristics of customers more likely to participate in the program (for example, "Age of head of household" is grouped into customers younger than 57 and customers 57 or older, with customers 57 or older more likely to participate). The tables included are for the 9 variables that were found to be significant in the model.

	0	1-750	751-1500	1501-2250	2251-3000	3001-3750	3751-4500	4501-5250	5251-6000	6001 and greater	Total
December Usage (Redeemers)	12	2581	2649	926	381	122	44	18	4	5	6742
	.2%	38.3%	39.3%	13.7%	5.7%	1.8%	.7%	.3%	.1%	.1%	100.0%

	0	1-750	751-1500	1501-2250	2251-3000	3001-3750	3751-4500	4501-5250	5251-6000	6001 and greater	Total
December Usage (All)	50	5439	5097	1773	707	259	95	38	15	11	13484
	.4%	40.3%	37.8%	13.1%	5.2%	1.9%	.7%	.3%	.1%	.1%	100.0%

	< 57	> = 57	Total
Age of head of household (Redeemers)	2762	3980	6742
	41.0%	59.0%	100.0%

	< 57	> = 57	Total
Age of head of household (All)	7443	6041	13484
	55.2%	44.8%	100.0%

	< 25,000	25,000 to 49,999	50,000 to 74,999	75,000 to 100,000	Over 100,000	Total
Family income (Redeemers)	887	1944	1537	1035	1339	6742
	13.2%	28.8%	22.8%	15.4%	19.9%	100.0%

	< 25,000	25,000 to 49,999	50,000 to 74,999	75,000 to 100,000	Over 100,000	Total
Family income (All)	2052	3764	2884	1956	2828	13484
	15.2%	27.9%	21.4%	14.5%	21.0%	100.0%

	Most likely to rent	Likely to rent	Least likely to rent	Likely homeowner	Most likely homeowner	Self reported homeowner	Total
Owner or renter probability (Redeemers)	76	470	94	198	333	5571	6742
	1.1%	7.0%	1.4%	2.9%	4.9%	82.6%	100.0%

	Most likely to rent	Likely to rent	Least likely to rent	Likely homeowner	Most likely homeowner	Self reported homeowner	Total
Owner or renter probability (All)	293	1548	238	385	548	10472	13484
	2.2%	11.5%	1.8%	2.9%	4.1%	77.7%	100.0%

	< = 6 years	Between 7 and 21	> 21 years	Total
Length of residence (Redeemers)	1651	2444	2647	6742
	24.5%	36.3%	39.3%	100.0%

	< = 6 years	Between 7 and 21	> 21 years	Total
Length of residence (All)	4051	5204	4229	13484
	30.0%	38.6%	31.4%	100.0%

	0	1	2	2	3	4	5	6	7	Total
Number of adults in household (Redeemer)	7	1225	1	2941	1495	687	271	89	26	6742
	.1%	18.2%	.0%	43.6%	22.2%	10.2%	4.0%	1.3%	.4%	100.0%

	0	1	2	2	3	4	5	6	7	8	Total
Number of adults in household (All)	16	3171	2	5930	2557	1174	453	144	34	3	13484
	.1%	23.5%	.0%	44.0%	19.0%	8.7%	3.4%	1.1%	.3%	.0%	100.0%

	0	< = 50,000	51,000 to 100,000	101,000 to 250,000	251,000 to 500,000	501,000 to 750,000	751,000 to 1 million	> 1 million	Total
Sales price of home (Redeemer)	2250	1063	1334	1789	273	30	1	2	6742
	33.4%	15.8%	19.8%	26.5%	4.0%	.4%	.0%	.0%	100.0%

	0	< = 50,000	51,000 to 100,000	101,000 to 250,000	251,000 to 500,000	501,000 to 750,000	751,000 to 1 million	> 1 million	Total
Sales price of home (All)	4645	2012	2570	3576	591	71	10	9	13484
	34.4%	14.9%	19.1%	26.5%	4.4%	.5%	.1%	.1%	100.0%

	1 = Most likely	2	3	4	5	6	7	8	9	10 = Least likely	Total
Internet Adoption score (Redeemer)	566 8.4%	497 7.4%	546 8.1%	547 8.1%	857 12.7%	738 10.9%	819 12.1%	862 12.8%	746 11.1%	564 8.4%	6742 100.0%

	1 = Most likely	2	3	4	5	6	7	8	9	10 = Least likely	Total
Internet Adoption score (All)	1379 10.2%	1195 8.9%	1250 9.3%	1251 9.3%	1820 13.5%	1578 11.7%	1546 11.5%	1440 10.7%	1129 8.4%	896 6.6%	13484 100.0%

	1 = Most likely	2	3	4	5	5	6	7	8	9	10 = Least likely	Total
Probability of revolving monthly payments (Redeemers)	562 8.3%	813 12.1%	624 9.3%	610 9.0%	1 .0%	586 8.7%	657 9.7%	676 10.0%	684 10.1%	819 12.1%	710 10.5%	6742 100.0%

	1 = Most likely	2	3	4	5	5	6	7	8	9	10 = Least likely	Total
Probability of revolving monthly payments (All)	1601 11.9%	1858 13.8%	1502 11.1%	1380 10.2%	3 .0%	1219 9.0%	1293 9.6%	1217 9.0%	1160 8.6%	1200 8.9%	1051 7.8%	13484 100.0%

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APPENDIX B

Low Income Refrigeration Program
Duke Energy Kentucky & Ohio
Savings Analysis
July 1, 2007 – June 30, 2008

September 2008

Submitted by Rick Morgan

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608-277-9518

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Refrigerator Analysis July 1, 2007 – June 30, 2008

Duke Energy Kentucky and its Energy Collaborative proposed and subsequently received approval to expand the low income weatherization program to include refrigerators as a qualified measure in owner occupied homes. This program was also approved by the Ohio Collaborative and the Ohio Public Service Commission and is offered in the Duke Energy Ohio territory. This memo is to report the data analysis to determine the average savings for the Low Income Refrigerator replacement program in combined Duke Energy Ohio & Kentucky territories during the report period July 1, 2007 to June 30, 2008.

Field Protocol

To understand the data results, it is important to understand the field protocol to determine the existing refrigerator's efficiency and whether it qualifies for replacement. The refrigerators are tested in homes that are being weatherized through either the Duke Energy Low Income Weatherization program and its delivery contractor, or the State Weatherization program delivery by the state weatherization agency in the area. When a delivery contractor auditor comes to the home to determine weatherization requirements, they install a digital power meter directly to the refrigerator. The refrigerator plugs into the power meter, manufactured by Brand Electronics, which then plugs into the wall. The auditor calibrates the unit and then lets it run for two hours at a minimum. Two hours is required so that the unit can stabilize and cycle. While more time would be optimal for increased accuracy, two hours has been shown to be able to determine poorly operating units that need to be replaced. [1]

The Protocol which follows specifies the steps that are taken by the auditor in the home and the applicable data entered.

Protocol Steps

1. *Clean refrigerator coils and Check seal on door gasket.*

---

[1] *SELECTION OF HIGH USAGE REFRIGERATORS AND FREEZERS* by Jim Mapp April 16, 1998. & *Low-Income Refrigerator Replacement – Selection Criteria for High Usage Refrigerator Replacement* by Jim Mapp Ph. D. Wisconsin Division of Energy, Kathy Schroder, Program Manager Cinergy Corp, and Rick Morgan, President Morgan Marketing Partners, 2001 IEPEC

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2. *Check to see that the refrigerator closes tightly.*
3. *Open door and take data:* *Brand* ____________________

   Model Number ____________________ *Size* ____________________

   Serial Number ____________________
4. *Close Door when compressor comes on and note wattage. (remember to zero the watt meter before you start)* *Running Wattage:* ____________ *watts*
5. *Let operate normally for two hours* *<u>or more</u>* *with door closed and take the total minutes and the kWhY reading (kWh per year estimate).*

   Total Minutes: ____________ *kWhY reading:* ____________
6. *Record peak running wattage at end of the test.* *Peak Watts* ____________
7. *If Peak Wattage is less than 325 watts <u>and</u> the refrigerator has an estimated annual energy usage <u>over 1315 kWhY</u> – **Replace the unit.***
8. *If Peak Wattage is more than 325 watts <u>and</u> the refrigerator has an estimated annual energy usage <u>over 1565 kWhY</u> – **Replace the unit.***

Additional Information Collected

- Customer Name
- Address Where Unit Installed
- Customer Duke Energy Electric Account Number
- Number in Family
- Square Feet of dwelling
- Replacement Unit Size in ft3
- Special Conditions in the home
- Date New Unit Ordered
- Date New Unit Delivered
- Old Unit Removed by
- A second refrigerator used by the customer to be removed
- Auditor Name

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The meter calculates the annual kWh consumption based on the watts used over the period of the test. If the refrigerator is calculated by the meter to consume over 1315 kWh year (kWhY) it is replaced at no charge to the customer. However, defrost cycles sometimes initiate over the two hour test period which would skew consumption estimates due to the defrost coils heating the unit. When a defrost cycle occurs the meter measures a higher peak watt consumption during the test which is seen in the data. If the unit shows higher than 325 peak watts during the test, it is assumed that the unit has gone into defrost mode. The 325 was chosen as most compressors use 250 watts or less to operate and then with the lights included, would equal 300 peak watts or less. When the unit shows this high wattage demonstrating defrost mode, the kWh per year must equal 1565 kWh or more to be replaced. Units that have bad seals as determined by the auditor can be replaced in special cases even if the meter wattage is below the requirement which happens approximately 5% of the time.

If a unit is found to need replacement, the auditor orders a unit from the specified vendor providing the Energy Star unit. Three sizes are available, 21 cubic feet, 18 cubic feet and 15 cubic feet. The auditor determines the size for the replacement. The auditor is allowed to go to larger sizes under special circumstances. Of the total units replaced during this period, 34% were 21 ft3, 58% were 18 ft3 and 8% were 15 ft3.

Old units are required to be removed by the refrigerator supplier at the time of the delivery of the new unit and the old unit is environmentally recycled. This assures that the old refrigerator does not continue to be used by the customer or get resold in the secondary market thus taking it permanently off the grid. If there is a second refrigerator on the premise that is working and the customer does not want it anymore, the program will remove and recycle the unit for free. The program has not been successful in getting second units removed as no second units were picked up during the reporting period. This may be an area that the program wants to pursue more aggressively in future years.

Field data is then entered into a database and was reviewed for this analysis. Savings are determined by taking the metered consumption estimate for the year (kWhY) minus the energy consumption rating for the specific Energy Star refrigerator replacing the original unit. These Energy Star consumption estimates are determined by the standardized manufacturer testing in accordance with Energy Star guidelines. Those consumption estimates are:

- 443 kWh/yr for 21 cubic foot
- 434 kWh/yr for 18 ft3
- 372 kWh/yr for 15 ft3

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Results

The program data show that there were 764 units tested in Ohio and Kentucky programs and 334 replaced. That is 44% replacement rate (the same replacement rate as last year).

Based on the July 1, 2007 to June 30, 2008 data from the field protocol outlined above, savings is on average 1154 kWh for all the units replaced. Last periods savings were 1089 showing consistency in application of the protocol and continued savings for the program. The highest savings was over 2800 kWh per year and the lowest 14 kWh. There were 33 units with less than the minimum savings (1315 kWhY minus 443 kWh of the 21 ft3 unit = 872 kWh). A majority had broken seals or other problems, however, these installations should be reviewed by Duke Energy to assure that the protocols are being followed by all auditors.

Savings broken down by state are as follows:

State	kWh Savings	Participants
Ohio	1176	249
Kentucky	1087	85

Note that these savings do not include any spillover or market effects from taking the old refrigerator off the secondary market.

The data used for analysis is within the attached spreadsheet. Due to privacy concerns, customer names have been removed.

DSMore Analysis

To complete the DSMore analysis of cost effectiveness, savings should be applied across all hours with an annual savings of 1154 kWh. By using the two hour meter test, natural diversity of load is automatically included, thus using Mode 2 standard testing will work. Life of the measure is related to how early the unit is being replaced. Effective useful life of the new unit is 8 years based on research completed in California on a long term

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recycling program.[2] This reflects the time the unit would be normally replaced with a new unit and the time that the replaced unit might be used as a secondary refrigerator before ultimate operations failure.

The refrigerator that is recycled earns some non-energy environmental benefits by ensuring that the collected refrigerators are processed and recycled in a manner that meets and exceeds both federal and state environmental laws and regulations. However, these benefits are not quantified here. Ozone-depleting chlorofluorocarbon refrigerants and foam insulation blowing agents (CFCs/HCFCs/HFCs), mercury, used oils, plastics, metals, and glass are recovered and recycled. Polychlorinated biphenyls (PCBs) are also recovered for disposal.

Cost for the program is approximately $1000 per replaced refrigerator which includes the refrigerator delivery cost, recycling, testing and administration. These costs vary slightly by size, but for modeling the $1000 average cost is appropriate.

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[2] *Residential Refrigerator Recycling Ninth Year Retention Study* Study ID Nos. 546B, 563 prepared for Southern California Edison Company by KEMA July 22, 2004

Final Report

An Evaluation of the Commercial and Industrial Incentive Program in Ohio

Results of a Process and Impact Evaluation

September 30, 2008

Prepared for

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Table of Contents

Executive Summary

About This Report

This report presents the results of a process and impact evaluation of Duke Energy's Commercial and Industrial Program as it operates in Ohio. The C&I Prescriptive Incentive Program provides incentives to customers to upgrade to an energy efficient option in existing facilities or for new construction. The available technologies include lighting, HVAC, refrigeration, motors, drives, pumps and other measures for the commercial and industrial sectors. The program is marketed through direct mail marketing and provides education, training, and sales support.

The first section provides the results from the process evaluation. The process evaluation employed in-depth interviews with program design, planning and implementation staff and C&I facility managers and short interviews with program participants.

The second section provides findings from the impact evaluation efforts. The impact evaluation employed a tracking system review, an engineering review of the lighting measures, and field measurement and verification (M&V) of selected lighting and HVAC measures. The tracking system review revealed that a few measures comprised the majority of the savings for lighting and HVAC measures. High bay lighting comprised the majority of the lighting savings, while programmable thermostats and variable frequency drives comprised the majority of the HVAC and motor savings. Field M&V was applied to these measures to verify their impacts.

Summary of Findings

An overview of the key findings identified through this evaluation is presented in this section.

Significant Process Evaluation Findings

Program Technologies

The equipment incentivized under the Ohio C&I Program are selected by a panel of industry experts and reviewed regularly. This practice ensures that the most efficient technologies are covered and incentivized by the program. The levels of satisfaction with the technologies offered by the program are very high in Ohio.

The Incentives

The incentives are altered according to the suggestions of the industry expert panel and are subject to change, potentially resulting in some participant dissatisfaction when they changed if they are changed without significant advanced notice to people who have moved into their participation decision-making process. However, while this condition cannot be avoided, it can be minimized. The incentives are not to exceed 50 percent of the incremental price of the energy efficient equipment. This incentive level is the results of a policy decision by Duke Energy and is consistent with programs that want to encourage energy efficiency upgrades but not pay the entire cost of the upgrade. As a result, when the market price changes, the program incentives need to change accordingly.

Program Satisfaction

The participants are very satisfied with the program and gave the program a score of 9.5 out of 10 with 10 indicating "very satisfied". The participants think it is a great program that provides an extra push to help customers make an energy efficient choice, and the vendors agree.

Significant Impact Findings

The gross energy and demand savings by measure estimated by this evaluation for the lighting measures studied are summarized in Table 1.

Table 1. Lighting Measure Savings

Lighting	kW/measure	kWh/measure
Central Lighting Control	3.120	11,500
CFL-Hardwired (fixture & bulb	0.074	565
CFL-Screw-in (bulb only)	0.037	181
LED Auto Traffic Signals (retrofit only)	0.085	275
LED Exit Signs Electronic Fixtures (retrofit only)	0.031	149
LED Pedestrian Signals (retrofit only)	0.044	150
Occupancy Sensors over 500 W *	0.270	994
Occupancy Sensors under 500 W *	0.110	397
T5 4 Lamp replacing T12	0.020	60
T5 HO 2 Lamp replacing T12	0.016	166
T5 HO 4 Lamp replacing T12	0.017	184
T5 HO High Bay 2L	0.151	1,426
T5 HO High Bay 4L	0.189	1,203
T5 HO High Bay 6L	0.078	377
T5 HO High Bay 8L	-0.029	-243
T8 High-bay- 4 ft 4 lamp	0.134	1,002
T8 High-bay- 4 ft 6 lamp	0.215	1,471
T8 High-bay- 4 ft 8 lamp	0.139	1,298
T8-2 ft 2 lamp	0.008	43
T8-4 ft 2 lamp	0.014	76
T8-4 ft 3 lamp	0.025	87
T8-4 ft 4 lamp	0.031	200
T8-8 ft 2 lamp	0.016	116

The gross energy and demand impacts for HVAC and motor measures studied in this evaluation are shown in Table 2.

Table 2. HVAC and Motor Measure Savings

Measure Type	Measure	kW/measure	kWh/measure	therm/measure
HVAC	Thermostats	-0.043	1,139	134
Motors and Pumps	Variable	0.000	1,155	0

	Frequency Drives			

The impact analysis was confounded by several factors that could be improved in the future:

1. **Ambiguity in measure descriptions**. The lighting measure descriptions in the tracking system for T-8 fluorescent lamps were somewhat ambiguous. Although the lamp type, length and number of lamps per fixture were recorded, the lamp watts were not. Several styles of T-8 lamps with varying input watts are available, and adding a lamp wattage description will better define the specific type of the installed measure.
2. **Lack of building type information.** Lighting and HVAC measure savings calculations rely on an understanding of the building type. An additional field indicating the building type or customer SIC or NAICS code was included in the program tracking database, but the data were sparsely populated.
3. **Errors in lighting program tracking database internal algorithms.** The lighting program tracking database carried estimates of energy and demand savings that were in error. These errors were identified during the course of conducting the evaluation, and revised savings estimates based on the tracked fixture type, installation quantity, and self-reported operating hours were developed.

Recommendations

1. If budget is available, include an energy audit of commercial and industrial facilities to the program offerings. Since the C&I Incentive Program is new in Ohio, many of the facility managers will need assistance in determining which measures will provide the most savings or which measures would have the fastest payback period, depending on the energy efficiency goals of the company.
2. Look for ways to simplify the online application. The program manager states that the application process is easier and faster with the online system. However, 19% of the surveyed participants expressed frustration with the application (that the calculations were daunting, that gathering some of the information needed was difficult, and that when filling out multiple rebate forms many of the fields had to be filled out again even though the information would not change.
3. Provide a split incentive so that vendors are incented to up-sell the businesses on the more efficient option. This would encourage the vendors to sell the program to more customers.
4. Provide the vendors with the tools they need to promote the program to their customers. They need the right materials and training to effectively sell the energy efficient option and promote the program.
5. Include custom projects in the program. According to the vendors, the prescriptive measures are not always the most efficient option. Program flexibility will increase program participation and energy savings.

Introduction

This report presents the results of a process and impact evaluation of the Commercial and Industrial Program as it is provided in Ohio. To conduct the process evaluation we interviewed program managers, partnering contractors, and program participants. To conduct the impact evaluation, we relied on an engineering analysis of information provided in the program tracking system combined with field measurement and verification (M&V) of key measures providing more than 95% of the total program savings.

Program Description

Duke Energy encourages its business customers to increase the energy efficiency of their facilities through their Commercial and Industrial Energy Efficiency Rebate Program. The equipment rebates provided through this program are available to Duke Energy's Ohio commercial and industrial customers with a demand of 500 kW or less. Eligible products include lighting equipment, HVAC equipment and motors and pumps. The energy efficient equipment can be installed in new or existing facilities; however some of the lighting product rebates apply only to retrofit applications. Customers may install the equipment themselves; however, those installations have to be inspected by Duke Energy before the rebate is awarded.

Evaluation Methodology

The study methodology consisted of the following efforts:

1. A process evaluation in which TecMarket Works surveyed 37 participants from a pool of available Ohio customers, and performed in-depth interviews with the program manager and 10 partnering contractors.

2. An impact analysis that combined a review of the program tracking system, engineering review of lighting savings estimates, and field measurement and verification of key lighting, HVAC and motor measures.

Process Evaluation

The process evaluation included a telephone interview with the Duke Energy program manager, interviews with ten partnering contractors and 37 program participants. The management and contractor interviews focused on the design, planning, and implementation of the program and a review of the program's goals and objectives. This interview was conducted with Connie Rhodes, Duke's Small Commercial and Industrial Program Manager. Interviews were also done with partnering contractors, in which we focused on program operations, their experiences with the program, reasons for participation, and market effects of the program. Interviews were also conducted with program participants, these interviews focused on their participation experiences, satisfaction with the program, the operations of the program, freeridership, and other subjects presented in this report.

The interviews were conducted in August 2008. All interviews followed formal evaluation interview protocols. These protocols are provided in Appendices A, B and C of this report and allow the reader to examine the range and scope of the questions addressed during the interviews.

Energy Impact Analysis

The impact evaluation employed a tracking system review, an engineering review of the lighting measure savings calculations, and field measurement and verification (M&V) of selected lighting, HVAC and motor measures. The tracking system review revealed that a few measures comprised the majority of the savings for lighting, HVAC and motor measures. High bay lighting comprised the majority of the lighting savings, while programmable thermostats and variable frequency drives comprised the majority of the HVAC and motor savings. Field M&V was applied to a sample of these measures to verify their impacts.

Lighting measures. We focused on the high bay applications, since these made up 75% of the total lighting savings. Engineering review of the lighting program savings involved a comparison of the measure savings recorded in the program tracking database to the savings estimates used in program design. This comparison revealed a problem with the tracking system savings estimates. The savings for each measure were recalculated using the fixture watt savings estimates developed during program design, measure counts as recorded in the tracking system, coincidence factors assigned by building type, and customer self-reported operating hours.

The evaluation also conducted field M&V of a sample of high bay lighting participants to estimate savings for this measure. The field M&V consisted of a site visit, verification of the quantity and type of incented lighting fixtures, verification of fixture wattage assumptions against manufacturer's catalog data, interviews with customers to identify the type and quantity of the replaced fixtures, and short-term monitoring of lighting system operation using light loggers to verify operating hours. The field M&V activities were conducted by Duke Energy contractors and the results were forwarded to BuildingMetrics for analysis. The field M&V activities were compliant with the International Performance Measurement and Verification Protocols (IPMVP) Option A – Partially measured, retrofit isolation protocol.

A sample frame of high bay lighting participants was developed by TecMarket Works and a random sample of 20 sites was selected. Each site was recruited for the M&V study by the Duke Energy M&V contractors. The contractors were successful in recruiting and installing instrumentation at 18 of the 20 sites.

Setback thermostats. Setback thermostats made up an additional 35% of the claimed savings. To evaluate this measure, surveyors employed by TecMarket Works conducted brief onsite surveys at a sample of setback thermostat participants. The onsite survey collected information about the thermostat setpoint temperatures and setback/setup schedules, AC equipment controlled by the thermostats, and basic building characteristics. The occupants were interviewed about pre-retrofit thermostats and HVAC control settings. These data were used to modify commercial building prototype DOE-2 simulation models and calculate savings for each sampled site.

BuildingMetrics developed the onsite survey instrument and trained the TecMarket Works survey staff that conducted the onsite surveys. A sample frame of programmable thermostat customers was developed by TecMarket Works and a simple random sample of 15 rebated thermostats was selected.

VFDs. Measurement and verification activities were conducted at a sample of VFD participants. A sample frame of VFD participants was developed by TecMarket Works and a random sample of 10 VFDs was selected. Duke technical staff installed instrumentation at the sampled drives and returned the monitored data to BuildingMetrics for analysis. The field M&V activities were compliant with the International Performance Measurement and Verification Protocols (IPMVP) Option B – Full-measured retrofit isolation protocol.

Section 1: Process Interview Results

A total of thirty-seven interviews were conducted with participants of the Small C&I Incentive Program in Ohio. All of the interviewees took part in one or more program offerings.

Program Objectives

The primary objective of the C&I Incentive Program is to raise the level of awareness of energy efficient technologies of Duke Energy's business customers in Ohio so that the commercial and industrial community will more rapidly consider making changes in energy efficiency of their business that can be expected to save them money on their energy bills. According to the program's operating theory, customers who improve the energy efficiency of their business will save money, improve the environment, and potentially improve worker productivity through better lighting and heating equipment.

A secondary objective of the program is to transform the market by increasing customer demand and contractor awareness of the covered technologies, resulting in moving the energy efficient equipment to become more of a standard practice for the market as a whole.

According to the program manager, these objectives are being met within the budgetary constraints of the program. However, this study finds that these objectives can be enhanced by getting the vendors more information about the program and the benefits of the technologies and by providing additional promotional materials that focus on the benefits of adopting energy efficient technologies.

To assist with the program design and operational conditions, Duke hired program design experts to help design the program. These experts included skilled program design professionals and experienced engineering firms. Together, the Duke Energy design team structured the program and its marketing operations and defined the measures that would cost effectively save energy. This team developed the initial list of measures to consider for the program and fine-tuned that list to improve the cost effectiveness of the programs. The measures included by the program are then reviewed annually to keep them current with technical advances in the market.

Vendor Participation Experience

During the interviews with the vendors, we asked about the level of involvement with the C&I Program and how they interacted with Duke and their customers. Most of the vendors inform their customers about the energy program's efficient options and the rebates offered by Duke Energy.

- I work for a distributor and work with businesses that are trying to lessen their cost per month on what they pay for their electric bill and give them a good return on their investment – I shoot for a payback period of 2 years or under. The program helps customers reach this goal so they can move up to the more efficient line.

- Customers call me about upgrades and rebates, and I inform them of the program if it fits their equipment needs and cost considerations.

- I work to try to save our customers money any way I can; I explain to them that there are Duke rebates to cut the cost of installation if they go with the more efficient choices.

- I advise my customers that there is rebate money available when they need mechanical upgrades, if they select the right equipment.

- I go around and let my customers know about the rebates that Duke has and the savings that they can expect. If they're interested in making these changes we get the prices for them. I tell them about the compact fluorescents and motion sensors as starting points.

- When we go out on sales calls we suggest using the more energy efficient products. At the same time we tell them about the C&I program and how it can save money and that they can get in contact with a duke representative if they are interested.

- Most of our customers are contractors, not owners, so when a plan comes out with specified fixtures on it, we quote that, but also offer an energy saving alternative and tell them about the program rebate. We use it as an up-sale approach when they specify the lower efficiency equipment.

- WE let the customer come to us about it unless they want to get a product that's covered under the program, then we tell them about the rebate.

Incentive Levels

All but two of the vendors thought that the incentive levels were appropriate and were an important influence on customer decisions to move to the more energy efficient equipment. Two thought there should be some changes to the incentive structures:

- The incentive level should be increased a bit. If the business is upgrading their equipment and it meets the requirements of the program, they'll apply for the rebate. I don't see it driving anyone to undertake a new project, but it can help in upgrades.

- The incentives were pretty good but they were changed. High bay rebates used to pay 80%, now it pays 50%. Most of the money early on went to new construction now more goes to upgrades I think.

Technologies Covered

Half of the vendors think that the list of technologies should be expanded to include the following:

- LED lighting technologies (n=3)

- Occupancy sensing for lighting systems

- Energy recovery ventilators and heat wheels.

None of the vendors suggested that any of the current technologies incented through the program should be removed.

Streamlining the Process

Two of the vendors think that the program application process can be streamlined by not making it necessary to provide cut sheets for every project. Their comments:

- We shouldn't have to worry about making everything match up perfectly with the cut sheets. It just makes the whole process more time consuming.
- We shouldn't have to submit cut sheets for everything in the world. Also, giving up information about the profitability of the business is not something that people want to do. Why do you need this confidential information?

Reasons for Participating

Vendors report that their primary reason for participating in the C&I program is to increase sales and profits. Their comments are below:

- It helps our sales, and also lessens the energy usage by customers.
- We participant because we want to sell and install the fixtures. This program allows us to offer them an incentive to buy the more efficient line, and offering free money keeps customers happy and gives us business.
- We have a lot of existing accounts that we do a lot of work for and we're trying to convert people over to new technologies that are more efficient. This helps us do that.
- We like adding value for the customer, it just lowers the overall cost and saves them money.
- The program helps our sales. The changeovers are no brainers when you factor in the incentive and the energy savings.
- The original thought was that it would help us make the sale, but it seems that our customers really want to reduce energy usage. This helps them do that.
- The program gives us the advantage of selling energy efficient products with the cost subsidizing influences of the incentive.
- Sales, we want to sell and want to be the leaders.
- It's a good program that helps customers, ourselves and Duke Energy.

- We want to provide energy efficient things to our customers, and this helps us do that by lowering costs for the energy efficient line.

Program Offerings and Potential Improvements

Some customers are looking for a better understanding of their facilities though an energy audit types of service. Currently, there are no Duke incentives for this type of activity. At the current time Duke is considering adding this service, along with custom project rebates, however, both of these are pending approval.

According to venders, the prescriptive rebate can be limiting, and in some cases potential projects are turned away (even though they are proposing a high efficiency option) because the program is not flexible enough to give credit for customized projects. Adding a custom component to the program may help achieve these savings if it is effectively designed and incorporated. This programmatic change has the potential of improving the program by opening it up to more energy efficient approaches and options to the commercial and industrial customers in Ohio. However, custom projects also require more time to consider because each project has to be individually assessed before it is approved.

Additional Services That Participants Would Like

During the short surveys with the program participants, we asked what additional services they would like to the program to include. The energy audit was the most requested service, followed by recommendations for adding custom measures and project rebates. The following recommendations were provided:

- Have the program include an energy audit (n=3)
- Add an incentive for automated lighting systems
- Provide a more clear explanation of the program's opportunities and offerings
- The program doesn't currently address the difference between standard T8s and high efficiency T8s
- The program could include boiler replacements
- Include incentives for solar or wind power and other renewable energy options
- Provide rebates for adding VFDs, not just for replacing them
- Provide rebates for new installations as well as retrofits
- Provide some help on the engineering side for specifying some of the systems, currently they have to rely on vendors which adds costs

Program Participation

We asked the participants what their primary reason was for their participation decision. Sixty-five percent of the participants indicated that the primary reason for purchasing or upgrading their equipment was for the energy savings. 21.6 percent said the reason for their participation was because of the incentive. Another 16.2 percent said the reason was because they needed to replace old equipment. A small percentage (5.4 percent) of the participants indicated that the main reason for the purchase was because it was recommended by their electrician. The other reasons provided relate in one way or another to the project. These responses are presented in Table 3 below.

Table 3. Motivating Factors for Participation

Motivating Factor	N	Percent
Wanted to reduce energy costs	24	64.9%
Other (see list below)	12	32.4%
The program incentive	8	21.6%
Old equipment working poorly	6	16.2%
Recommendation of someone else (see list below)	4	10.8%
The information provided by the program	1	2.7%
Old equipment didn't work	1	2.7%

If the respondent provided a motivating factor that was not on the survey instrument's list, it was noted as "other" and that factor was recorded in the interview records. The responses from twelve respondents are below:

- We needed better illumination in our facility. (n=5)
- We developed a comprehensive energy efficiency program, and the program provided an easy way to start us on the right path.
- We were moving into a new facility and looking for ways to be more energy efficient.
- We were looking for new way to increase the payback time for new equipment.
- Our company developed a new plan that included a desire to "go green".
- We were moving into an old building and needed to improve the energy efficiency in any way we could.
- We were remodeling and looking for ways to improve the efficiency of the building.
- We wanted the tax incentive that comes with moving towards increased efficiency.

Five of them were in need of better lighting in their facilities, and this need led them to be interested in the program.

Four of the participants said that they participated in the program based on a recommendation by someone else, including;

- Electrician (n=2)
- Rich Dunaway
- A customer that's also an electric company

The C&I Application Process and Rebate

The applications to receive the rebate are all available on line (they used to be mailed). This change is a recent improvement in the program. The applications are organized by technology so a lighting vendor (for example) does not have to spend time searching through materials that only apply to a furnace rebate. This is an effective way to structure the information.

The online application includes a lot of information, such as:

- Instructions for filing the application
- Incentive values
- Eligibility requirements
- FAQs
- A contact number for the customer or vendor to call to get help, if needed.

The participants are satisfied with the program application and rebate form and scored their satisfaction with the form a mean value of 8.3 on a 10-point scale. See the Section on Program Satisfaction for more details on participants' thoughts on the program application.

The program manager believes that the incentives are high enough, and most of the participants agree. Program staff performs an annual review of the incentive levels and technologies that are included in the program, and makes adjustments to better fit the market as needed. For example, when a measure is starting to become the market standard, such as T8s in new construction, the incentive is removed from new construction and only available to companies that are retrofitting. The general rule of thumb for incentives is that it is not to exceed 50% of the incremental cost for the measure, and according to the program manager, this is followed in 80% of the installations.

Nine of the ten vendors agree that the program covers the proper technologies. The one negative comment provided was:

- When the list of technologies was developed, it seems like there was not a lot of thought put into it. Low power ballasts can't be used. White reflectors can't be used. However, 8 foot fixtures don't get a rebate.

Increasing Participation

We asked the participants for ways in which Duke Energy could increase interest and participation in the program. The most popular response received was not about rebate levels, but rather a suggestion that Duke Energy increase their general advertising of the program. Fifty-one percent of the participants provided this response. Twenty participants had other suggestions including:

- advertise more (n=15)
  - especially to building owners, property managers and supply houses
  - use bill inserts
  - The program is probably due for another round of advertising for the program, some have forgotten about it or not thought about it for a while
  - send something to people that purchase new buildings
- increase web presence, it's really hard to find information about the program on the

website, you really have to look for it
- add more technologies to the program
- tell people about savings with easy to understand comparisons
- publicize it more, people want high efficiency anyway so why not get a rebate and help them accomplish this
- increase the rebates and offer the energy audit to tell them what can be updated
- increase the rebate levels
- contact the larger uses and promote it directly to them
- focus on conveying awareness of potential savings and payback, tell about the cost of not improving
- education on how much money is being wasted with inefficient equipment
- promote it more, not very heavily promoted, print media and radio media
- show them the lights and the value of the lights and motion detectors for larger places
- better partnership with direct vendors, not with customers, the people selling the equipment
- interact with the vendors a little more so that the lighting vendors can contact the companies, wouldn't have known about it unless the supplier told him
- have Duke pay for the installation and then transfer the costs to all customers through their bills

Two of the vendors think that program participation levels can be increased and provided suggestions for increasing participation:

- Identify a group of competent electrical contractors that are able to do the retrofitting of buildings and promote the program with those players.

- There needs to be a meeting with Duke explaining what they're doing, where they're at and where they plan to go. There is a lot of uncertainty surrounding the program and its permanency.

Beyond the comments received above, the evaluation has identified additional consideration pertaining to participation rates.

The program has a web site that serves as centralized location for all the program information. All updates to the program are presented there first. This provides a way for vendors and customers to stay up-to-date on program changes if the vendors and customers can easily go to the websites and find the information.

Duke Energy's outreach efforts include an annual process in which a list of eligible customers is compiled. This list is then used for a direct mail campaign. One of the barriers to the campaign bringing in more participants is that Duke Energy doesn't always have the correct contact person to whom facilities change information can be addressed. Because the contact name is often the person who deals with bill payments, and not facility upgrades, the direct marketing materials may not reach the right person.

Duke also does a mailing to all the vendors to let them know about the program and the measures that are included. Both past program participants and new vendors are included in this mailing. (Typically the new vendors that are added to the list are obtained from third-part market information suppliers.)

Other possible methods for increasing participation include bill inserts to their commercial customers, presentations and discussions with trade ally groups, presentations and discussions with contractors and business partners, advertising or public service announcements in trade journals, case stories in business publications, journals, industry newsletters, industry awards ceremonies, etc. Duke should explore these potential avenues to see which marketing efforts are cost effective and can be developed within the programs management and marketing budgets.

Program Satisfaction

We asked participants three questions about their satisfaction with various program components. We asked them to rate their satisfaction on a 10-point scale with 1 meaning they strongly disagree with the statement and 10 meaning they strongly agree with the statement. If a participant scored any of the aspects with a score of 7 or lower, we asked the participant how that aspect could be improved. Each of the program aspects are discussed below, with the participant scores provided in Figure 1.

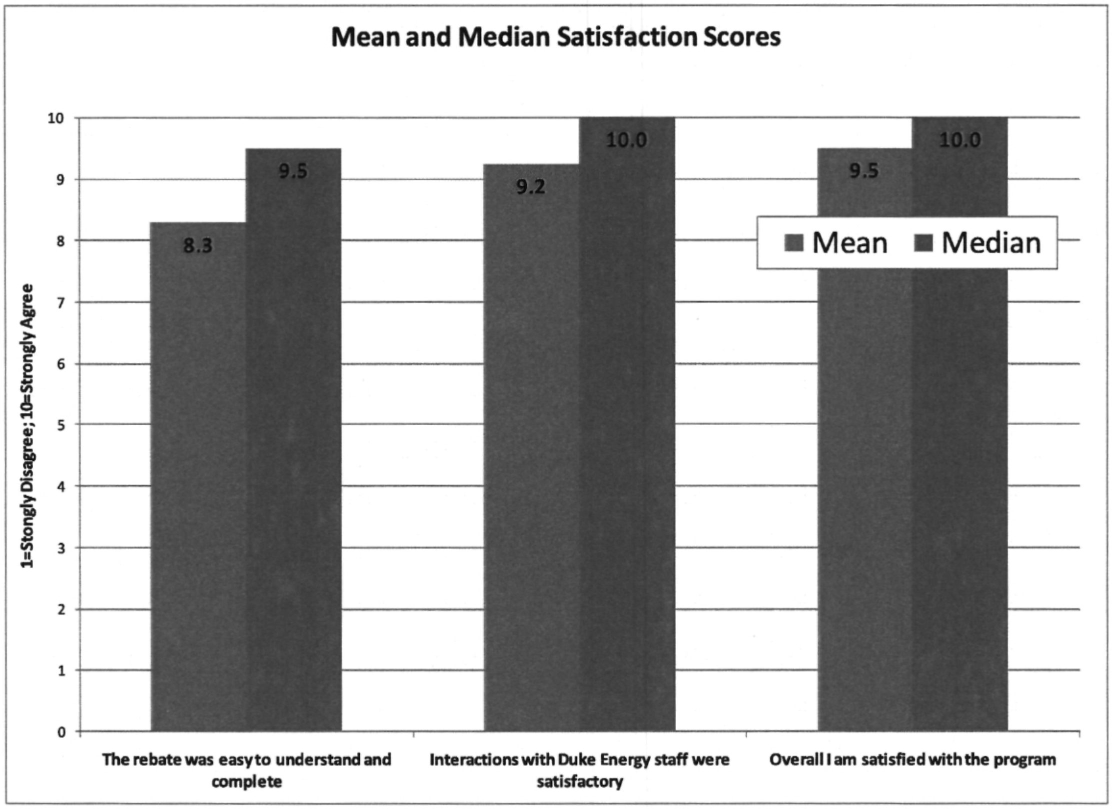


Figure 1. Participant Satisfaction Scores

Program Rebate

The program's rebate received the lowest mean satisfaction score of 8.3 on a 10-point scale. The median score is 9.5, indicating that half of the respondents gave the rebate forms a high score of 10. However, there were 7 scores that were below 7 on the 10-point scale, which prompted a follow up question about why they scored the rebate form so low. The dissatisfaction centers on the rebate forms and the time it takes to fill them out. The responses are:

- I had to call the vendor a couple of times to ask questions about the form.
- I didn't like the part where the vendor had to sign the form, it was hard to get in contact with him.
- It was difficult to get all the information together, didn't know exactly what was being asked for at times.
- I had to read the forms several times to understand it, and the calculations in there are a pain.
- I had to send in multiple applications and each time I had to send in new forms. They are so long, it just seems silly to have to fill them out.
- I needed to get help from the vendor since I wasn't sure what was being asked, I couldn't do it alone which was very frustrating and time-consuming.
- Some of the information they want for the forms took a while to gather.

The amount of time to receive the rebate did not come up during this question, however it did in other parts of the interview. Overall, the turnaround time for the rebate is very good. The goal of the program is to have the incentive check out within five business days of approval. The mean period of time it took to process the rebate and approve the cutting of the check is seven days, according to program records. This is a very fast turnaround time compared to other programs we have evaluated.

Interactions with Duke Energy

Satisfaction with the interactions with Duke and program staff was rated very high, receiving a mean score of 9.2 and a median score of 10. The two participants that gave a score of 7 or lower had the following comments:

- The interactions were above average, but nothing beyond what is expected
- My rebate check was mailed to the wrong address resulting in some hassles

C&I Program Overall

The program overall received an average score of 9.5 and a median score of 10. This indicates that the program has a few areas in which at least half the participants are, to a limited degree, slightly dissatisfied with a component of the program. Satisfaction with a program impacts the level of support that participants can provide to the program. This in turn impacts one of the most effective information dissemination method by which word of the program spreads in a market – peer-networking. However, as noted by the overall high satisfaction score, the limited number of dissatisfaction comments and the subject of those comments, we conclude that satisfaction is high and there are few issues effecting satisfaction rates. Each of the program aspects that a contractor voices some level of dissatisfaction with the overall program are provided below.

- The rebates could be larger, they are not quite enough to convince some people.
- I would like to see different technologies covered, such as more efficient boilers.
- More technologies are needed, some utilities have incentive programs for generators where if they need you to go offline, they give you credits for going offline.
- I only had one issue and that was how long it took to get the check. (Records for this individual indicate that it took 21 days from installation to mail the rebate check. However, in this case, the check was mailed to the wrong address, resulting in further delays.)

There is also a limited level of dissatisfaction being expressed to the vendors by their customers. We asked the vendors if any of their customers complained about the program, and two of the ten interviewed vendors were able to provide examples of customer complaints:

- I've had complaints from people that don't get their rebate in a timely manner, which I think comes back to the amount of paperwork.

- Customers say they need to have a high power factor ballast and they have to provide a ballast cut sheet, even for fluorescent high bays.

What Works Well

We asked the participants what they liked most about the program. Many of them (32%) cited the rebates are their favorite part of the program. Many of the participants said that the program was simple and straight-forward, while others were pleased that Duke Energy was taking a pro-efficiency and pro-environmental stand by offering the program and incentives. The following responses were provided by participants when we asked them what they liked most about the program.

- Getting the rebate. (n=12)
- It's very simple to apply for the rebate. (n=2)
- Getting the rebate - this helped us to move to a more efficient operation.
- The visit from the representative was a nice touch and was very much appreciated.
- It helped cut initial investment costs.
- That Duke Energy is providing encouragement for long term energy efficiency.
- The information provided about availability of energy efficient options.
- The end result of saving some money on energy bills
- That Duke Energy is really motivating the owners to make energy efficient improvements.
- That Duke is rebating some pretty common sense technology that is readily available, and incenting business owners to take action
- It's a friendly and straightforward program that helps the business community.
- It was really simple to get the rebate and I was surprised at how quick I got the check.
- The rebate dollars were significant, and everything was very timely.
- The installers did all the work including the paperwork, which left me to focus on my job.
- That Duke is promoting high efficiency measures that are good for the environment.
- The way the vendor handled everything for me.
- The program staff and vendors were easy to get along with and talk to.
- The turnaround time on the rebate is impressive.
- It's a very simple and straight forward program.

What Doesn't Work

We also asked the participants what their least favorite aspect of the program was. We received fewer responses to this question than the previous question on their likes. A few of them mentioned the paperwork involved and that they would have liked a larger rebate. The responses are summarized below:

- The paperwork involved was difficult (n=2)
- The amount of the rebate
- A larger rebate would have helped more, but I was still happy to get some incentive to make the improvement.

- The application appeared to be pretty straightforward, but it was returned so it is not as simple as we thought.
- There was a lot of disruption to the shop employees during the installation.
- I'd prefer it if someone could do the paperwork for me. It took too much time and effort and kept me from other duties.
- Not enough business owners know about the program. Duke needs to get the word out more because more people would take advantage of this program.
- The rebate check was mailed to the wrong address, resulting in a delay.
- It was a hassle to get back in contact with the vendor to get him to sign off on something on the application.
- The language on the application was a little difficult when it's split up between lighting, HVAC, etc… but our vendor was able to interpret it for us.
- I don't like the minimum billing provisions, as we won't realize savings until the second year.
- I really needed the vendor to fill out the forms because I don't know all that stuff on my own.
- The forms were terrible and a huge hassle to complete, especially for repeat applications, just doesn't make any sense to have to repeatedly enter in the same information.

We also asked the program manager what changes are needed to the program operations and management. The reply indicated that there is a need for better targeting of the marketing and getting the right contact person at the businesses and this is something that is being worked on currently. The manager also mentioned that the vendors need the right tools, training and materials to be able to effectively sell the high efficiency equipment.

The manager also indicated that vendors frequently call to say they can do something more efficient than the prescriptive measures allow, but the program doesn't have the flexibility to yet accommodate that. This may well be an energy savings barrier for Duke to overcome with a custom program component. Offering a custom incentive will help achieve this goal, and make the program more accessible to vendors and customers. It may also be beneficial to have a split incentive, where the vendors receive incentives for helping the businesses make the energy efficient choice.

The vendors were also asked about what kinds of problems they have had with the C&I program. The most common complaint is with the amount of paperwork and the amount of time it takes to fill it out.

- Biggest problem I've had is with the program incentive changes and Duke wanting more information on the application form. They want information that isn't standard. It takes a long time to get it all together.

- There isn't much communication with Duke on the contracting side of it. Would like to see communications beefed up.

- The amount of paperwork is foolish. It's bogging the process down.

- There's quite a bit of paperwork to fill out. It's time consuming.
- The amount of time the contractors spend filling out the paperwork is an issue for us.
- I am sometimes concerned that the funding will run out before the incentives are sent out. I don't feel 100% confident that the checks will really come.

Section 2: Energy Impact Analysis and Findings

The impact evaluation employed a tracking system review, an engineering review of the lighting measure savings calculations, and field measurement and verification (M&V) of selected lighting, HVAC and motor measures. The tracking system review revealed that a few measures comprised the majority of the savings for lighting and HVAC measures. High bay lighting comprised the majority of the lighting savings, while programmable thermostats and variable frequency drives comprised the majority of the HVAC and motor savings. Field M&V was applied to a sample of these measures to verify their impacts. Tracking data obtained from Duke Energy through April, 2008 shows that following breakdown of energy savings by measure:

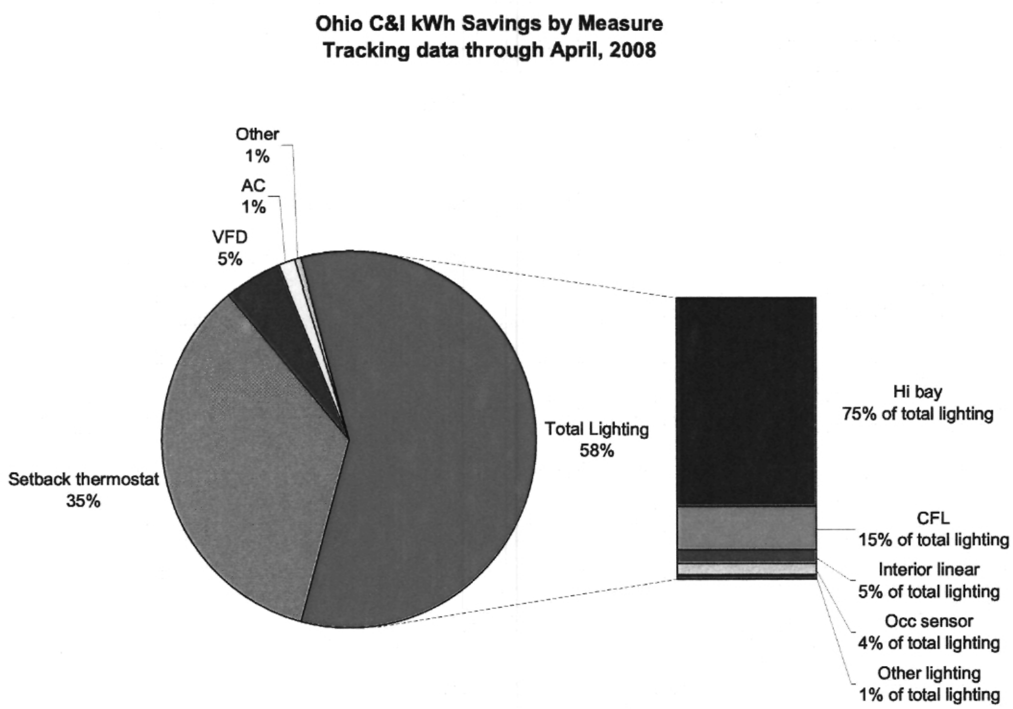


Figure 2. Measure Contribution to Ohio C&I Program Savings.

Note, lighting, setback thermostats and variable frequency drives (VFDs) made up 98% of the total reported savings. Lighting was dominated by high-bay applications, making up 75% of the total lighting savings. Based on this analysis, the impact evaluation was conducted as follows:

Lighting measures. We focused on the high bay applications, since these made up 75% of the total lighting savings. Engineering review of the lighting program savings involved a comparison of the measure savings recorded in the program tracking database to the savings estimates used in program design. This comparison revealed a problem with the tracking system savings estimates. The savings for each measure were recalculated using the fixture watt savings estimates developed during program design, measure counts as recorded in the tracking system, coincidence factors assigned by building type, and customer self-reported operating hours.

The evaluation also conducted field M&V of a sample of high bay lighting participants to estimate savings for this measure. The field M&V consisted of a site visit, verification of the quantity and type of incented lighting fixtures, verification of fixture wattage assumptions against manufacturer's catalog data, interviews with customers to identify the type and quantity of the replaced fixtures, and short-term monitoring of lighting system operation using light loggers to verify operating hours. The field M&V activities were conducted by Duke Energy contractors and the results were forwarded to BuildingMetrics for analysis. The field M&V activities were compliant with the International Performance Measurement and Verification Protocols (IPMVP) Option A – Partially measured, retrofit isolation protocol.

A sample frame of high bay lighting participants was developed by TecMarket Works and a random sample of 20 sites was selected. Each site was recruited for the M&V study by the Duke Energy M&V contractors. The contractors were successful in recruiting and installing instrumentation at 18 of the 20 sites.

Setback thermostats. Setback thermostats made up an additional 35% of the claimed savings. To evaluate this measure, surveyors employed by TecMarket Works conducted brief onsite surveys at a sample of setback thermostat participants. The onsite survey collected information about the thermostat setpoint temperatures and setback/setup schedules, AC equipment controlled by the thermostats, and basic building characteristics. The occupants were interviewed about pre-retrofit thermostats and HVAC control settings. These data were used to modify commercial building prototype DOE-2 simulation models and calculate savings for each sampled site.

BuildingMetrics developed the onsite survey instrument and trained the TecMarket Works survey staff that conducted the onsite surveys. A sample frame of programmable thermostat customers was developed by TecMarket Works and a simple random sample of 15 rebated thermostats was selected.

VFDs. Measurement and verification activities were conducted at a sample of VFD participants. A sample frame of VFD participants was developed by TecMarket Works and a random sample of 10 VFDs was selected. Duke technical staff installed instrumentation at the sampled drives and returned the monitored data to BuildingMetrics for analysis. The field M&V activities were compliant with the International Performance Measurement and Verification Protocols (IPMVP) Option B – Full-measured retrofit isolation protocol.

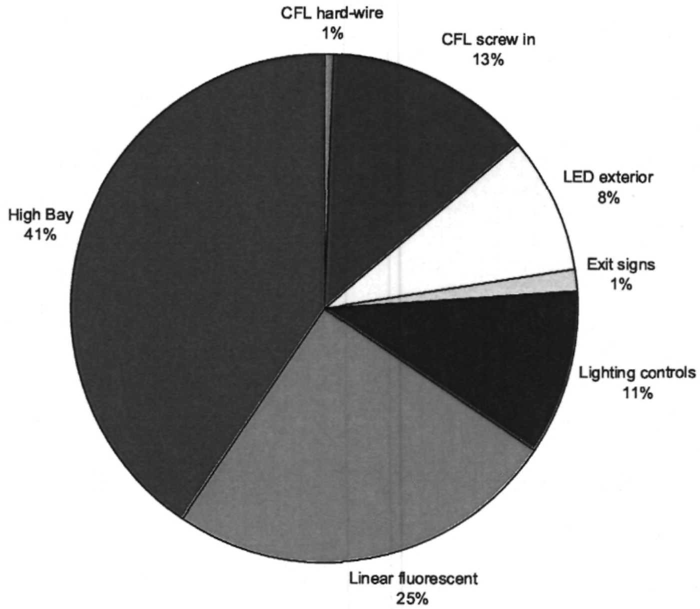
Lighting Analysis

Lighting program participation records covering the period from January, 2007 through mid June, 2008 were obtained from Duke Energy. The data, delivered as an Access database, contained customer name and address, installing vendor contact information, measure descriptions, unit energy savings estimates, number of measures installed, lighting operating hours, installed fixture watts, rebate amounts, and so on. These data were examined to identify which of the measures promoted by the program were adopted by program participants and in what numbers, how the energy savings in the tracking system compared to the program savings estimates, and the availability of any customer description data that could be used in the analysis. The lighting program tracking system showed lighting measures installed in sites representing a total of 352 participating customers. The types and quantity of measures installed are shown in Table 4.

Table 4. Lighting Measures Installed Under Program

Measure	Measure Group	Installation counts
CFL-Hardwired (fixture & bulb)	CFL hard-wire	267
CFL-Screw-in (bulb only)	CFL screw in	5,215
LED Auto Traffic Signals (retrofit only)	LED exterior	2,640
LED Exit Signs Electronic Fixtures (retrofit only)	Exit signs	531
LED Pedestrian Signals (retrofit only)	LED exterior	678
Occupancy Sensors over 500 W *	Lighting controls	321
Occupancy Sensors under 500 W *	Lighting controls	2,288
Switching Controls for Multilevel Lighting	Lighting controls	1,568
T5 4 Lamp replacing T12 (retrofit only)	Linear fluorescent	30
T5 HO 2 Lamp replacing T12 (retrofit only)	Linear fluorescent	152
T5 HO 4 Lamp replacing T12 (retrofit only)	Linear fluorescent	230
T5 HO High Bay 2L (retrofit only)	High Bay	566
T5 HO High Bay 4L (retrofit only)	High Bay	3,339
T5 HO High Bay 6L (retrofit only)	High Bay	972
T5 HO High Bay 8L (retrofit only)	High Bay	548
T8 High-bay- 4 ft 4 lamp (retrofit only)	High Bay	1,529
T8 High-bay- 4 ft 6 lamp (retrofit only)	High Bay	8,379
T8 High-bay- 4 ft 8 lamp (retrofit only)	High Bay	557
T8-2 ft 2 lamp (retrofit only)	Linear fluorescent	33
T8-4 ft 2 lamp (retrofit only)	Linear fluorescent	3,837
T8-4 ft 3 lamp (retrofit only)	Linear fluorescent	2,086
T8-4 ft 4 lamp (retrofit only)	Linear fluorescent	3,032
T8-8 ft 2 lamp (retrofit only)	Linear fluorescent	464

The distribution of measure installations by the measure groups defined above is shown in Figure 3.



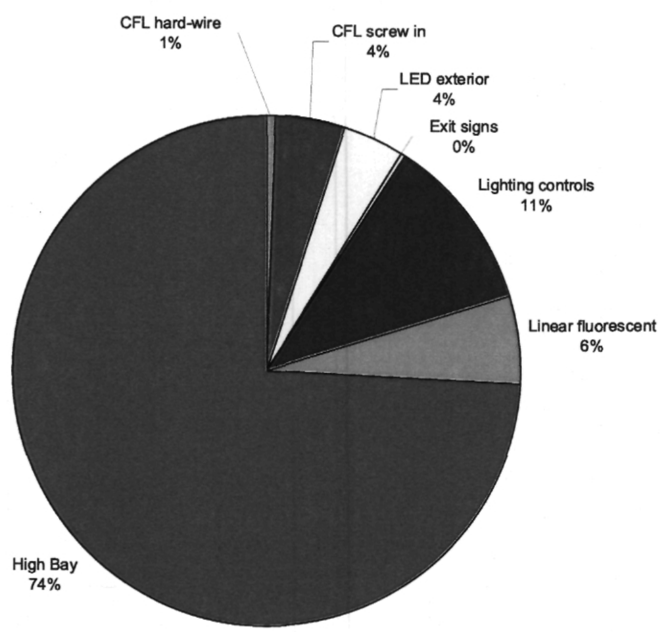


Figure 3. Distribution of Lighting Measure Installation Counts by Measure Group

Revised Tracking System Gross Energy and Demand Savings.

As mentioned above, the algorithms used by the program tracking database to record energy and demand savings were found to be in error. A set of revised energy and demand savings estimates were developed for each measure in the program tracking database using the following engineering equations:

$$kW_{savings} = \sum_{i}^{buildings} \sum_{j}^{measures} units_{i,j} \times kWsaved_j \times CDF_i$$

$$kWh_{savings} = \sum_{i}^{buildings} \sum_{j}^{measures} units_{i,j} \times kWsaved_j \times FLH_{i,j}$$

where:

units = quantity of each measure installed in each building type
kWsaved = unit kW savings for each measure
CDF = coincident demand factor by building type
FLH = customer self reported full load lighting hours as reported in program tracking database

The unit kW savings[1] assigned to each lighting measure are shown in Table 5.

Table 5. Lighting Fixture Wattage Savings Assumptions

Description	Measure Wattage	Baseline Fixture	Baseline Wattage	Watt/fixture savings
320W MH PS	342	400 W HID	455	113
CFL-Hardwired (fixture & bulb)	27	2-60W Inc Fixture	120	93
CFL-Screw-in (bulb only)	15	60 W Incandescent	60	45
T5 1 Lamp replacing T12	32	T12- 34W - 4' 1 Lamp - Magnetic	44	12
T5 4 Lamp replacing T12	126	T12- 34W - 4' 4 Lamp - Magnetic	150	24
T5 HO 2 Lamp replacing T12	122	T12 - 8' and 4' Avg	141	19
T5 HO 4 Lamp replacing T12	243	T12 - 60W - 8' 4 Lamp - Magnetic	264	21
T5 HO High Bay 2L	121.5	175 W HID	215	93.5
T5 HO High Bay 4L	243	400 W HID	455	212
T5 HO High Bay 6L	365	400 W HID	455	90
T5 HO High Bay 8L	486	400 W HID	455	-31
T8 High-bay- 4 ft 4 lamp	142	250 W HID	290	148
T8 High-bay- 4 ft 6 lamp	224	400 W HID	455	231
T8 High-bay- 4 ft 8 lamp	299	400 W HID	455	156
T8 HO- 8 ft 2 lamp	160	T12 - 95W - 8' 2 Lamp - Magnetic - HO	210	50
T8-2 ft 1 lamp	20	T12 - 20W -2' 1 Lamp - Magnetic	27.5	7.5
T8-2 ft 2 lamp	33	T12 - 20W -2' 2 Lamp - Magnetic	43	9.5

[1] Based on lighting fixture wattage data developed by Franklin Energy Services (FES) for Duke Energy

T8-2 ft 3 lamp	48	T12 - 20W -2' 3 Lamp - Magnetic	68	20
T8-2 ft 4 lamp	63	T12 - 20W -2' 4 Lamp - Magnetic	85	22
T8-3 ft 1 lamp	26	T12 - 30W -3' 1 Lamp - Magnetic	37	11
T8-3 ft 2 lamp	43	T12 - 30W -3' 2 Lamp - Magnetic	53	10
T8-3 ft 3 lamp	78	T12 - 30W -3' 3 Lamp - Magnetic	90	12
T8-4 ft 1 lamp	30	T12- 34W - 4' 1 Lamp - Magnetic	44	14
T8-4 ft 2 lamp	60	T12- 34W - 4' 2 Lamp - Magnetic	77	17
T8-4 ft 3 lamp	88	T12- 34W - 4' 3 Lamp - Magnetic	120	32
T8-4 ft 4 lamp	112	T12- 34W - 4' 4 Lamp - Magnetic	150	38
T8-8 ft 1 lamp	58	T12 - 60W - 8' 1 Lamp - Magnetic	69	11
T8-8 ft 2 lamp	112	T12 - 60W - 8' 2 Lamp - Magnetic	132	20

Note, the T5 HO High Bay 8L fixture uses more watts than the 400 W metal halide baseline fixture, thus the negative unit energy savings. This fixture provides more lumens than the baseline fixture, but not enough lumens to be a viable one for one replacement with the next highest standard metal halide lamp size (750W). Unit demand and energy savings assumptions for LED fixtures and lighting controls[2] are shown in Table 6.

Table 6. Unit Demand and Energy Savings for LED and Lighting Control Measures

Fixture	KWh/unit	KW/unit
LED Auto Traffic Signals (retrofit only)	275	0.085
LED Exit Signs Electronic Fixtures (retrofit only)	149	0.031
LED Pedestrian Signals (retrofit only)	150	0.044
Occupancy Sensors over 500 W *	994	0.27
Occupancy Sensors under 500 W *	397	0.11
Switching Controls for Multilevel Lighting	0.8	0.00022

The lighting coincident diversity assumptions were developed from load research studies on commercial lighting systems conducted by Pacific Gas and Electric Company and Southern California Edison. These data were applied to each measure according to the measure type and building type. Note, the building type field in the project tracking database was very sparsely populated, thus most buildings were assigned the average CDF of 0.84.

Table 7. Coincident Demand Factor Assumptions by Building Type

Building Type	Count	CDF
Church	1	0.76
College	1	0.68
Community Center	1	0.76
Elem/Secondary School	4	0.42
Grocery	1	0.88
Industrial	8	0.99

[2] Based on lighting fixture energy and demand savings data developed by Franklin Energy Services (FES) for Duke Energy

Medical Office	1	0.81
Office	4	0.81
Other/DK	1	0.76
Restaurant	1	0.68
Retail	17	0.88
University	2	0.68
Warehouse	5	0.84
Average		0.84

High Bay Lighting M&V Study

A sample of 20 customers installing High Bay Lighting fixtures was selected. We were successful in recruiting and obtaining data from 18 of the 20 customers. A summary of the characteristics of the customers that participated for the High Bay Lighting Study is shown in Table 8.

Table 8. High Bay Lighting M&V Study Participants

Site	Business Type	Total fixtures rebated	Installed Fixture(s)	Baseline Fixture(s)
1	HVAC supply	40	T5 HO High Bay 4L	400 W MH
2	Manufacturing	14	T5 HO High Bay 6L and T5 HO High Bay 8L	400 W MH
3	Printing	49	T8 High-bay- 4 ft 6 lamp	400 W MH
4	Industrial Supply	36	T8 High-bay- 4 ft 6 lamp	T12 8 ft HO 2L
5	Steel supply and fabrication	170	T5 HO High Bay 4L	400 W MH
6	Construction Equipment Rental	106	T8 High-bay- 4 ft 6 lamp	400 W MH
7	School	18	T5 HO High Bay 2L	175 W MH
8	Electrical equipment supply	15	T8 High-bay- 4 ft 6 lamp and T5 HO High Bay 6L	400 W MH
9	Auto Repair	15	T8 High-bay- 4 ft 6 lamp	T12 8 ft 2L
10	Manufacturing	120	T5 HO High Bay 6L	400 W HPS
11	Boat Dealership	129	T8 High-bay- 4 ft 4 lamp and T8 High-bay- 4 ft 6 lamp	250 W MH and 400 W MH
12	Bottling Plant	740	T8 High-bay- 4 ft 6 lamp and T8 High-bay- 4 ft 8 lamp	400 W MH
13	Steel Fabrication	11	T5 HO High Bay 4L and T5 HO High Bay 6L	400 W MH
14	Printing and supply	69	T5 HO High Bay 6L	400 W MH
15	Manufacturing	26	T5 HO High Bay 4L	400 W MH
16	Foodservice supply	16	T8 High-bay- 4 ft 6 lamp	T12 8 ft HO 2L
17	Steel fabrication	300	T5 HO High Bay 4L and T5 HO High Bay 6L	400 W MH
18	Industrial Supply	30	T8 High-bay- 4 ft 6 lamp	400 W MH

Paper file applications and supporting documentation were obtained for each site. The data in the application files were reviewed and compared to the program tracking database and onsite survey observations. Discrepancies were noted and corrected for the impact evaluation. These discrepancies are reported in Table 9. Note, 3 of the projects in the sample were ineligible for the program, since they did not replace HID lighting systems.

Table 9. Tracking System and Paper File Discrepancies

Site	Discrepancy
Site 1	4L T8 in tracking system; 4L T5 installed
Site 2	Application and tracking system showed all 6L fixtures. Invoice showed combination of 6L and 8L fixtures
Site 4	Ineligible baseline fixture, must be HID
Site 5	170 fixtures replaced 186 baseline fixtures
Site 7	Application showed T5 HO High Bay 2L; tracking system showed T5 HO High Bay 4L
Site 9	Application and tracking showed T8 High-bay- 4 ft 8 lamp; invoice showed T8 High-bay- 4 ft 6 lamp. 15 new fixtures replaced 10 existing fixtures. Ineligible baseline fixture, must be HID
Site 10	Voltage entered instead of fixture watts on application
Site 13	No fixture watts entered on application
Site 17	Ineligible baseline fixture, must be HID

Fixture watts reported in the manufacturer's catalogs (where available) were averaged and compared to the standard assumptions used in program design for several popular fixture types. This comparison is shown in Figure 4.

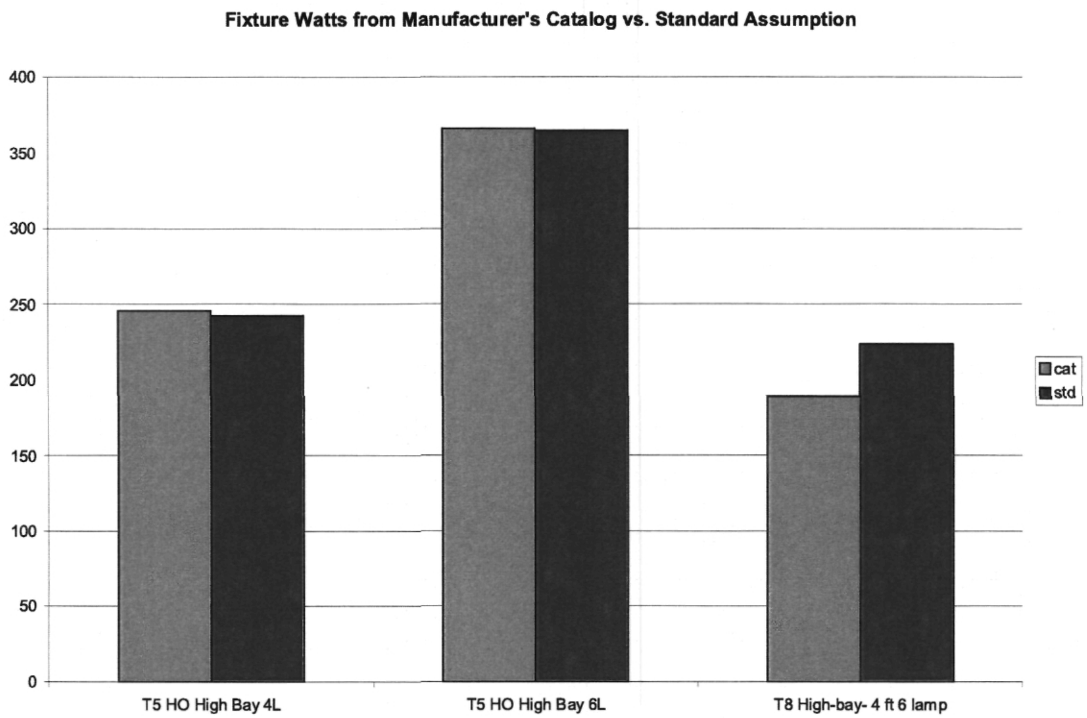


Figure 4. Comparison of Installed Fixture Watts from Manufacturers vs. Standard Assumptions

The average fixture watts from the manufacturer's catalogs matched the program design assumptions fairly well for T5 HO 4 lamp and 6 lamp fixtures. The program design used a higher (more conservative) assumption for fixture watts for the T8 4 ft 6 lamp fixture.

The ability of the program applicants to accurately report the fixture watts on the program application was investigated. A comparison of the fixture watts on the application vs. the manufacturer's catalog data is shown in Figure 5.

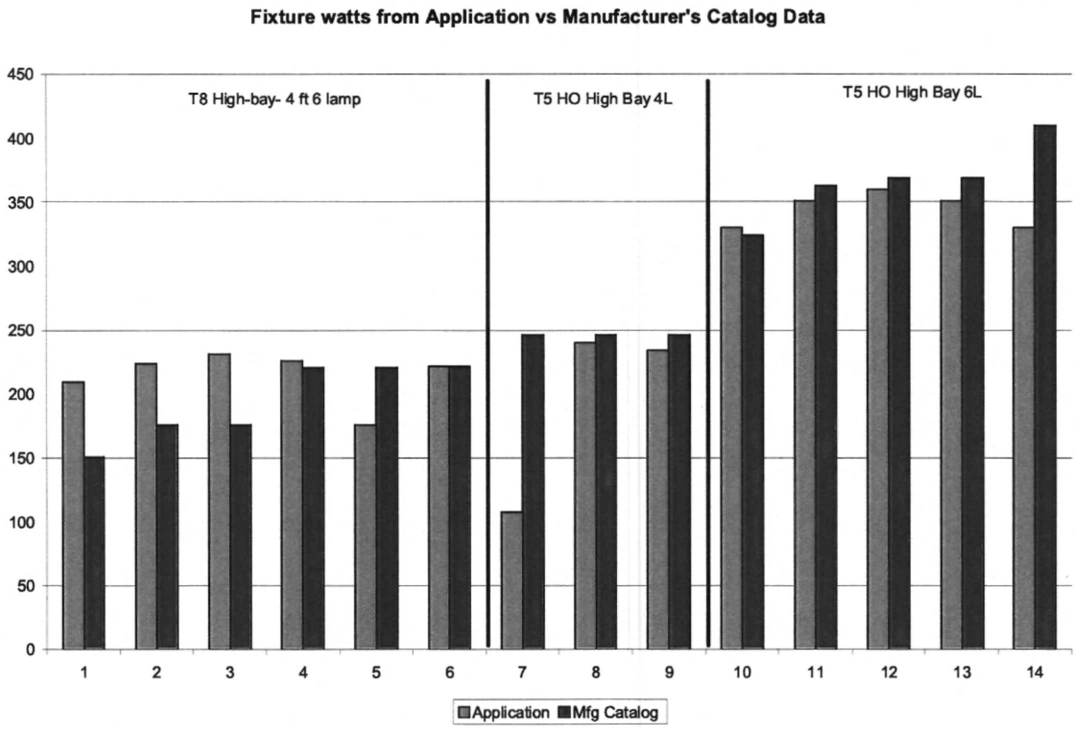


Figure 5. Comparison of Fixture Watts from Applications vs. Manufacturers' Catalog Data

Customer self reports of installed fixture watts varied widely from the data reported in the manufacturer's catalogs.

The fixture types and quantities installed at the sampled sites along with the number of light loggers deployed are shown in Table 10. Light loggers were deployed to monitor the on/off behavior of the lighting systems based on the circuiting and switching of the lighting systems. Due to group switching of multiple high bay fixtures, it was possible to monitor the on/off behavior of many fixtures with each light logger.

Table 10. Logger Installations at M&V Study Sites

Site	Business Type	Total fixtures rebated	Loggers installed
1	HVAC supply	40	4
2	Manufacturing	14	3
3	Printing	49	6
4	Industrial Supply	36	6
5	Steel supply and fabrication	170	3
6	Tool Rental	106	2
7	School	18	1
8	Electrical equipment supply	15	4
9	Auto Repair	15	2
10	Manufacturing	120	4
11	Boat Dealership	129	5

12	Bottling Plant	740	6[1]
13	Steel Fabrication	11	2
14	Printing and supply	69	2
15	Manufacturing	26	6
16	Foodservice supply	16	1
17	Steel fabrication	300	7
18	Industrial supply	30	3

[1]90% of the installed fixture watts verified to be on 24/7. Loggers placed in areas where lights were not continuously operated.

The light logger data were downloaded by the Duke Energy contractors, with assistance from Duke Energy evaluation staff. Several logger files that were corrupted due to logger battery failure were repaired by Duke Energy evaluation staff and sent to BuildingMetrics for further processing. A power outage in the Cincinnati area due to Hurricane Ike occurred during September 14 – 16. Data for these days were excluded from the analysis of affected customers.

Average operating hours by day type (weekday, Saturday and Sunday) were tabulated from the logger data and extrapolated to annual operating hours. A summary of the lighting logger results is shown in Table 11.

Table 11. Lighting Logger Study Results

Site	Business Type	Application self reported annual operating hours	Logger study annual operating hours	% difference
1	HVAC supply	2,600	2,793	7.4%
2	Manufacturing	7,500	8,451	12.7%
3	Printing	4,000	3,850	-3.8%
4	Industrial Supply	2,340	2,402	2.6%
5	Steel supply and fabrication	5,000	7,179	43.6%
6	Tool Rental	2,400	3,513	46.4%
7	School	3,200	3,140	-1.9%
8	Electrical equipment supply	2,340	1,825	-22.0%
9	Auto Repair	2,340	2,635	12.6%
10	Manufacturing	5,500	4,036	-26.6%
11	Boat Dealership	4,000	2,578	-35.6%
12	Bottling Plant	6,722	8,558	27.3%
13	Steel Fabrication	2,600	5,622	116.2%
14	Printing and supply	2,940	2,001	-31.9%
15	Manufacturing	2,340	2,873	22.8%
16	Foodservice supply	5,220	6,257	19.9%
17	Steel fabrication	5,453	5,185	-4.9%
18	Industrial supply	3,120	6,559	110.2%
	Average difference			16.4%

On average, the light logger study predicted about 16% more operating hours than the customer self reports.

The light logger results were combined with the verified fixture counts, verified installed fixture watts and monitored coincidence factors to estimate the actual energy and peak demand savings. These results are shown in Table 12 as Eval kWh and Eval kW. These results were compared to the revised tracking system estimates based on engineering calculations derived from the program tracked fixture types and counts, standard wattage savings by fixture type, self-reported operating hours, and coincidence factors by building type, shown as Rev Trk kWh and Rev Trk kW. The ratio of the evaluated savings to the engineering estimated savings is expressed as a realization rate (RR) for both kWh and kW.

Table 12. Results of High Bay Lighting M&V Study

Site	Business Type	Eval kWh	Rev Trk kWh	RR (kWh)	Eval kW	Rev Trk kW	RR (kW)
1	HVAC supply	25,472	29,214	0.87	9.1	9.2	0.99
2	Manufacturing	10,040	9,450	1.06	1.2	1.0	1.15
3	Printing	44,710	45,276	0.99	9.3	9.3	1.00
4	Industrial Supply	951	17,775	0.05	0.40	6.2	0.06
5	Steel supply and fabrication	270,533	180,200	1.50	37.7	29.6	1.28
6	Tool Rental	87,881	53,678	1.64	25.0	18.3	1.36
7	School	5,539	6,228	0.89	1.1	2.6	0.41
8	Electrical equipment supply	7,570	7,778	0.97	4.1	2.7	1.52
9	Auto Repair	12,279	5,476	2.24	4.7	1.9	2.43
10	Manufacturing	50,854	59,400	0.86	12.6	8.9	1.42
11	Boat Dealership	56,334	60,632	0.70	21.9	16.4	1.33
12	Bottling Plant	1,280,371	878,685	1.46	142.1	118.5	1.20
13	Steel Fabrication	8,270	3,843	2.15	1.5	1.2	1.21
14	Printing and supply	14,773	12,965	1.14	4.4	3.6	1.22
15	Manufacturing	15,836	12,898	1.23	5.5	4.5	1.22
16	Foodservice supply	250	8,811	0.03	0.03	1.4	0.02
17	Steel fabrication	202,215	213,758	0.95	39.0	32.1	1.21
18	Industrial supply	57,614	21,622	2.66	8.8	5.7	1.55
	Sample Average			**1.19**			**1.14**

The average realization rates for kWh and kW for the sample are 1.19 and 1.14 respectively. Thus, the evaluation study estimated 19% more kWh savings and 14% more kW savings than the revised tracking database calculations.

The overall lighting energy and demand savings for all participants are shown in Table 13. High bay fixtures savings were adjusted by applying the realization rates calculated by the M&V study to the revised tracking system savings estimates. Savings for the other fixture types were based on unadjusted revised tracking system savings estimates.

Table 13. Lighting Program Gross Energy and Demand Savings

Measure	Count	KW	KWh	KW/unit	KWh/unit
Central Lighting Control		328	1,207,500		

CFL-Hardwired (fixture & bulb	267	20	150,861	0.074	565
CFL-Screw-in (bulb only)	5215	192	941,486	0.037	181
LED Auto Traffic Signals (retrofit only)	2640	224	726,000	0.085	275
LED Exit Signs Electronic Fixtures (retrofit only)	531	16	79,119	0.031	149
LED Pedestrian Signals (retrofit only)	678	30	101,700	0.044	150
Occupancy Sensors over 500 W *	321	87	319,074	0.270	994
Occupancy Sensors under 500 W *	2288	252	908,336	0.110	397
Switching Controls for Multilevel Lighting	1568	0	1,254	0.000	1
T5 4 Lamp replacing T12 (retrofit only)	30	1	1,814	0.020	60
T5 HO 2 Lamp replacing T12 (retrofit only)	152	2	25,299	0.016	166
T5 HO 4 Lamp replacing T12 (retrofit only)	230	4	42,311	0.017	184
T5 HO High Bay 2L (retrofit only)	566	78	663,853	0.138	1,173
T5 HO High Bay 4L (retrofit only)	3339	578	3,304,284	0.173	990
T5 HO High Bay 6L (retrofit only)	972	70	301,009	0.072	310
T5 HO High Bay 8L (retrofit only)	548	-15	-109,578	-0.027	-200
T8 High-bay- 4 ft 4 lamp (retrofit only)	1529	189	1,260,477	0.123	824
T8 High-bay- 4 ft 6 lamp (retrofit only)	8379	1,657	10,135,971	0.198	1,210
T8 High-bay- 4 ft 8 lamp (retrofit only)	557	71	594,675	0.128	1,068
T8-2 ft 2 lamp (retrofit only)	33	0	1,421	0.008	43
T8-4 ft 2 lamp (retrofit only)	3837	53	290,830	0.014	76
T8-4 ft 3 lamp (retrofit only)	2086	52	182,330	0.025	87
T8-4 ft 4 lamp (retrofit only)	3032	95	607,864	0.031	200
T8-8 ft 2 lamp (retrofit only)	464	8	53,940	0.016	116
Total for Program		**3,991**	**21,791,830**		

HVAC Measure Analysis

An analysis of the program tracking database showed that programmable thermostats made up the majority of the HVAC claimed savings, as shown in Figure 6. Thus, the evaluation focused on setback thermostats only.

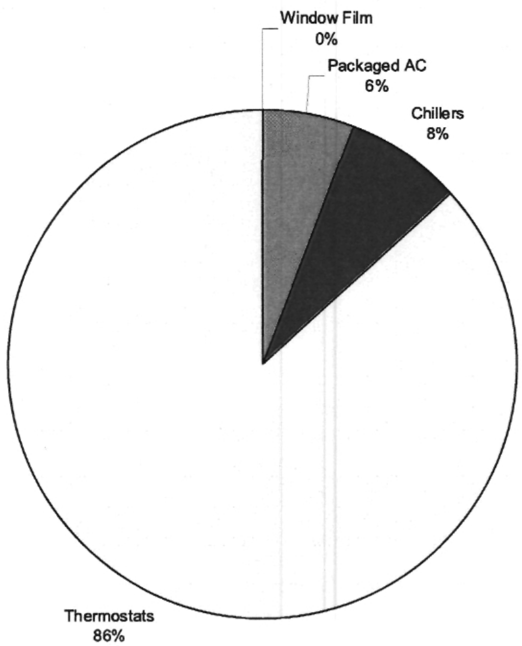


Figure 6. HVAC Claimed Savings by Measure.

To evaluate setback thermostats, surveyors employed by TecMarket Works conducted brief onsite surveys at a sample of participants. The onsite survey collected information about the thermostat setpoint temperatures and setback/setup schedules, air-conditioning equipment controlled by the thermostats, and basic building characteristics. The occupants were interviewed about pre-retrofit thermostats and HVAC control settings. These data were used to modify a commercial building prototype DOE-2 simulation models and calculate savings for each sampled site.

BuildingMetrics developed the onsite survey instrument and trained TecMarket Works survey staff who conducted the onsite surveys. BuildingMetrics and TecMarket Works collaborated on the sample selection and projection of savings from the sampled sites to the participant population. A simple random sample of 15 thermostats was selected. The selected thermostats were installed at four different customer sites. The surveyors contacted and recruited the customers for the onsite inspections. Once at the site, the surveyors selected a representative sample of thermostats within each building.

Table 14. Setback Thermostat Study Participants

Site	Building Type	Thermostats installed	Thermostats sampled
1	Large Downtown Office	50	11
2	Auto Dealership	4	2
3	Funeral Home	10	1
4	Restaurant	1	1

Total	15

The characteristics of the spaces associated with each of the sampled thermostats are shown in Table 15.

Table 15. Spaces Associated with Sampled Thermostats

No	Building	Space	SF
1	Large Downtown Office	Bsmt Mail Room	1440
2	Large Downtown Office	Bsmt conf	1089
3	Large Downtown Office	Bsmt break	1200
4	Large Downtown Office	2nd fl conf	720
5	Large Downtown Office	2nd fl bldg mgt	504
6	Large Downtown Office	1st fl conf	1008
7	Large Downtown Office	1st fl guard shack	120
8	Large Downtown Office	1st fl retail	1110
9	Large Downtown Office	2nd fl comp room	432
10	Large Downtown Office	2nd fl office	270
11	Large Downtown Office	2nd fl conf	540
12	Auto Dealership	Office	372
13	Auto Dealership	Parts Counter	147
14	Funeral Home	Viewing room	1296
15	Restaurant	Cafeteria	1100

The onsite survey collected data on thermostat make and model, heating and cooling setpoints and schedules, and fan operation. Customers were interviewed to gather information about the use and settings of the replaced thermostat. Customer responses to the survey are summarized in Table 16.

Table 16. Thermostat Setpoint and Fan Operation Survey Results

		Heating						Cooling						Fan Operation	
		New thermostat			Replaced thermostat			New thermostat			Replaced thermostat			New	Replaced
Tstat	Day	Occ hours	Occ setpt	Unocc setpt	Occ hours	Occ setpt	Unocc setpt	Occ hours	Occ setpt	Unocc setpt	Occ hours	Occ setpt	Unocc setpt	Cont	Cont
1-11	M-F	6-18	72	62	1-24	72	NA	5-18	72	82	1-24	72	NA	Cont	Cont
	Sat	7-12	72	62	1-24	72	NA	7-12	72	82	1-24	72	NA	Cont	Cont
	Sun/Hol	NA	NA	62	1-24	72	NA	NA	NA	82	1-24	72	NA	Cont	Cont
12-13	M-F	6-17	71	68	6-17	71	68	6-17	73	75	6-17	73	75	Cycle	Cycle
	Sat	8-15	71	68	8-15	71	68	8-15	73	75	8-15	73	75	Cycle	Cycle
	Sun/Hol	NA	NA	68	NA	NA	68	NA	NA	75	NA	NA	75	Cycle	Cycle
14	All	7-17	72	60	1-24	70	NA	7-17	72	80	1-24	74	NA	Cont	Cycle
15	M-Sun	8-22	65	55	1-24	65	NA	8-22	72	78	1-24	72	NA	Cont	Cont
	Hol	NA	NA	55	1-24	65	NA	NA	NA	78	1-24	72	NA	Cont	Cont

The customer site associated with each thermostat was assigned to a prototype DOE-2.2 building energy simulation model[3]. The large downtown office was assigned to the large office prototype, the auto dealership was assigned to the retail prototype, the funeral home was assigned to the assembly prototype and the restaurant was assigned to the full-service restaurant prototype. The surveyed heating and cooling setpoint schedules and fan operating schedules were entered into the DOE-2.2 models, and the energy and summer peak demand savings per square foot of conditioned floor space was simulated. The energy and demand savings per square foot calculated by the DOE-2.2 simulations is shown in Table 17.

Table 17. Energy and Demand Savings for Each Sampled Thermostat

Tstat	Building	Space	SF	kWh/ 1000 SF	kW/ 1000 SF	therm/ 1000 SF	kWh/tstat	kW/tstat	therm/ tstat
1	Large Office	1	1,440	1,899	-0.048	228	2,734	-0.069	328
2	Large Office	2	1,089	1,899	-0.048	228	2,068	-0.052	248
3	Large Office	3	1,200	1,899	-0.048	228	2,278	-0.058	274
4	Large Office	4	720	1,899	-0.048	228	1,367	-0.035	164
5	Large Office	5	504	1,899	-0.048	228	957	-0.024	115
6	Large Office	6	1,008	1,899	-0.048	228	1,914	-0.048	230
7	Large Office	7	120	1,899	-0.048	228	228	-0.006	27
8	Large Office	8	1,110	1,899	-0.048	228	2,107	-0.053	253
9	Large Office	9	432	1,899	-0.048	228	820	-0.021	99
10	Large Office	10	270	1,899	-0.048	228	513	-0.013	62
11	Large Office	11	540	1,899	-0.048	228	1,025	-0.026	123
12	Auto Dealership	1	372	0	0.000	0	0	0.000	0
13	Auto Dealership	2	147	0	0.000	0	0	0.000	0
14	Funeral Home	1	1,296	-2,403	-0.012	-725	-3,114	-0.015	-939
15	Restaurant	1	1,100	3,807	-0.200	938	4,188	-0.220	1,032
Average Savings per Thermostat							**1,139**	**-0.043**	**134**

Note, the customer use of thermostats 12 and 13 was unchanged relative to the replaced thermostat, thus no savings were realized. Thermostat 14 fan operation changed from cycling to continuous, causing an increase in energy consumption overall. Return from setback during workdays caused an increase in summer peak demand, thus a negative demand impact resulted. Energy and demand impacts per thermostat calculated for the sample is compared to the energy savings per thermostat used in the program tracking database in Table 18.

Table 18. Comparison of Energy and Demand Savings Relative to Tracking System Estimates

Source	KWh/thermostat	KW/thermostat	Therm/thermostat
Tracking database	9,017	1.75	
Evaluation	1,139	-0.043	134
Realization rate	0.13	-0.03	

The energy savings predicted by this evaluation were only 13% of the savings estimates used in the program tracking database. Demand savings predicted by the evaluation were negative.

[3] See Appendix xx for a description of the prototype building energy simulation model.

The realization rates for the programmable thermostats estimated from this evaluation were applied to all thermostat measures in the program tracking database. Savings for the other HVAC measures were unadjusted. The total gross HVAC savings are shown in Table 19.

Table 19. Gross HVAC Savings by Measure and Program Total

Measure	kW savings	kWh savings
Unitary AC <65,000 BTUH (1 phase)	0	407
Unitary AC 65,000 - 135,000 BTUH	18	16,860
Unitary AC 136,000 - 240,000 BTUH	107	45,668
Unitary AC 241,000 - 760,000 BTUH	73	80,824
Unitary HP 136,000 - 240,000 BTUH	7	9,418
Rooftop AC 65,000 - 135,000 BTUH	9	8,539
Rooftop AC 136,000 - 240,000 BTUH	64	59,218
Rooftop AC 241,000 - 760,000 BTUH	108	106,167
Rooftop AC >760,000 BTUH	55	33,002
Air Cooled Chillers	78	71,346
Water Cooled Chillers > 300 ton	293	254,980
Water Cooled Chillers 150 - 300 ton	184	167,900
ES Window AC under 14,000 Btu/hr	0	70
ES Sleeve AC over 14,000 Btu/hr	13	19,570
Setback/Programmable Thermostat	-33	740,837
Window Film	3	4,044
Total HVAC savings	**977**	**1,618,850**

Motors and Pumps

An analysis of the program tracking database showed that variable frequency drives (VFDs) made up the majority of the claimed savings for motor and pump measures, as shown in Figure 7.

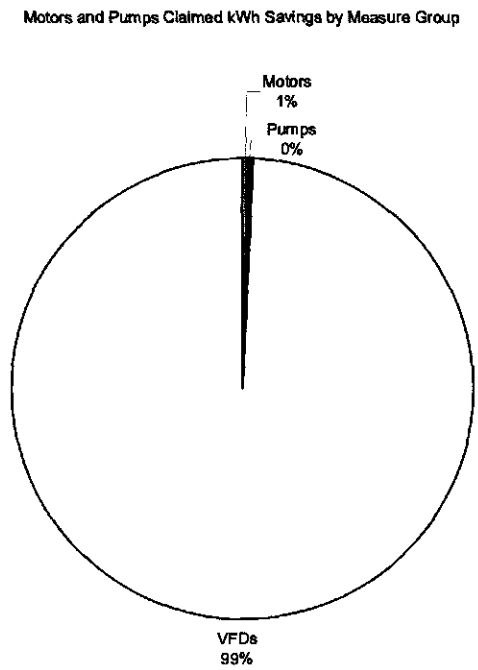


Figure 7. Distribution of Motor and Pump Savings by Measure

Thus, the evaluation focused on VFDs only. Measurement and verification activities were conducted at a sample of VFD participants. On-site M&V efforts were compliant with the IPMVP Option B – Fully Measured Retrofit Isolation protocol. TecMarket Works developed a sample frame and selected a simple random sample of 10 VFDs for the M&V study. A contractor supplied by Duke Energy contacted and recruited the customers for the M&V study. Once at the site, the contractor selected a representative sample of VFDs within each building. The Duke Energy contractor installed true electric power meters at the sampled VFDs and monitored each VFD for approximately two weeks. The data loggers were downloaded by the contractor and the data were sent to BuildingMetrics for analysis.

The characteristics of the sites associated with the sampled VFDs are shown in Table 20.

Table 20. VFD Monitoring Sample Site Characteristics

Site	Measure	Number installed at site	Sample	Application
Asphalt Plant	VFD HP 150	1	1	Asphalt plant exhauster
Mail sorting facility	VFD HP 20	38	4	HVAC AHU supply fan
Mail sorting facility	VFD HP 5	36	4	HVAC AHU return fan
Downtown Office	VFD HP 25	1	1	Exhaust fan / building pressurization control
Total			10	

Time series kW data were obtained and analyzed for each VFD. To estimate savings, an equivalent baseline kW time series was estimated through an engineering analysis. Variable inlet vanes were assumed to be the baseline fan volume control method for HVAC applications. Discharge damper control was assumed to be the baseline fan volume control method for the asphalt plant. Since the monitoring occurred during the summer, the maximum kW demand associated with the monitored data was assumed to represent full fan flow rate. The fraction of the maximum kW was calculated at each interval, and the fraction of full flow was calculated assuming a cubic power relationship between flow rate and input power:

$$H = f^3$$

where:

f = flow ratio

$$= \frac{CFM}{CFM_{max}}$$

H = ratio of fan power at flow ratio f to the maximum fan power

$$= \frac{kW(f)}{kW_{max}}$$

The cubic relationship shown above was used to calculate the full flow fraction at each interval.

The equivalent baseline kW fraction was calculated as a function of the flow fraction according to the baseline flow control strategy assumed.[4] For inlet vane control, the following relationship was used:

$$H = a + \frac{f}{b + c \times f^2}$$

where:

$$a = 0.354$$

$$b = \frac{2 - p_0}{0.646}$$

$$c = \frac{p_0 - 1}{0.646}$$

[4] Fan flow vs. power relationships taken from Englander, S. and L. Norford; "Variable-Speed Drives: Improving Energy Consumption Modeling and Savings Analysis Techniques," Proceedings of the ACEEE 1992 Summer Study on Energy Efficiency in Buildings; American Council for an Energy-Efficient Economy, Washington, D.C., 1992.

p_0 = ratio of the static pressure setpoint of the controller to the static pressure at the fan discharge (assumed to be 1).

For discharge damper control, the following relationship was used:

$$H = 0.646f + 0.354$$

These relationships were used to construct an equivalent baseline kW time series, which was used to estimate the savings at each interval from each drive.

Weather data corresponding to the monitoring period were obtained from the National Climatic Data Center for the Cincinnati area. Temperature data corresponding to a typical two-week monitoring period are shown in Table 21.

Table 21. Ambient Temperature Data during VFD Monitoring Period

Date	Tmax	Tmin	T Avg
9/1/2008	91	57	74
9/2/2008	96	67	81.5
9/3/2008	95	67	81
9/4/2008	86	67	76.5
9/5/2008	82	67	74.5
9/6/2008	81	59	70
9/7/2008	78	56	67
9/8/2008	82	56	69
9/9/2008	73	52	62.5
9/10/2008	77	49	63
9/11/2008	86	55	70.5
9/12/2008	77	69	73
9/13/2008	91	68	79.5
9/14/2008	90	65	77.5
9/15/2008	71	53	62
9/16/2008	75	49	62

Note, the maximum temperature recorded during this period was 96 deg F, which exceeds the 1% design condition for Covington, KY (90 deg F).

These data were used to explore the weather dependence of the energy saving. The daily kWh savings were plotted against daily average dry bulb temperature for each drive. Some of the energy savings were shown to be weather dependent, while other savings data were not, indicating that some the selected drives were associated with air handlers serving interior zones of the buildings and were thus not strongly affected by the outdoor temperature. The asphalt plant fan and the exhaust/building pressurization fan were clearly not weather dependent. An example of a weather dependent AHU fan is shown in Figure 8.

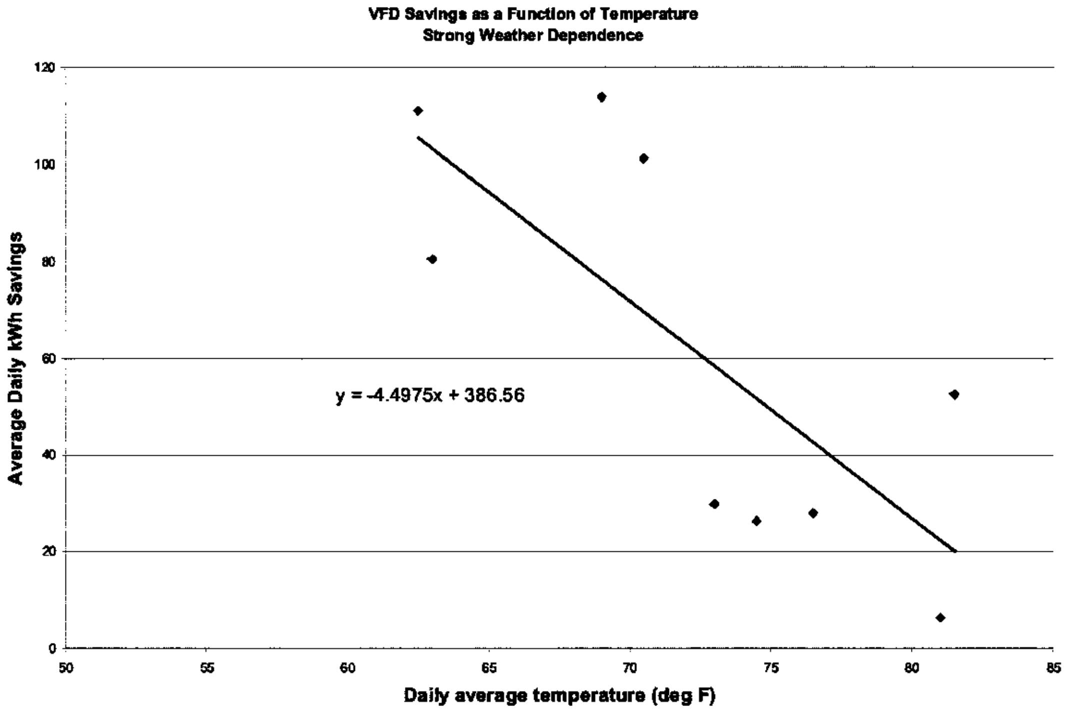


Figure 8. Temperature Dependent VFD Energy Savings

The energy savings approach zero as the outdoor temperature increases, which is expected as the fan operates close to full flow during the hottest weather. Savings increase as the temperature decreases due to lower fan speeds at reduced cooling loads. An example of a weather independent drive is shown in Figure 9.

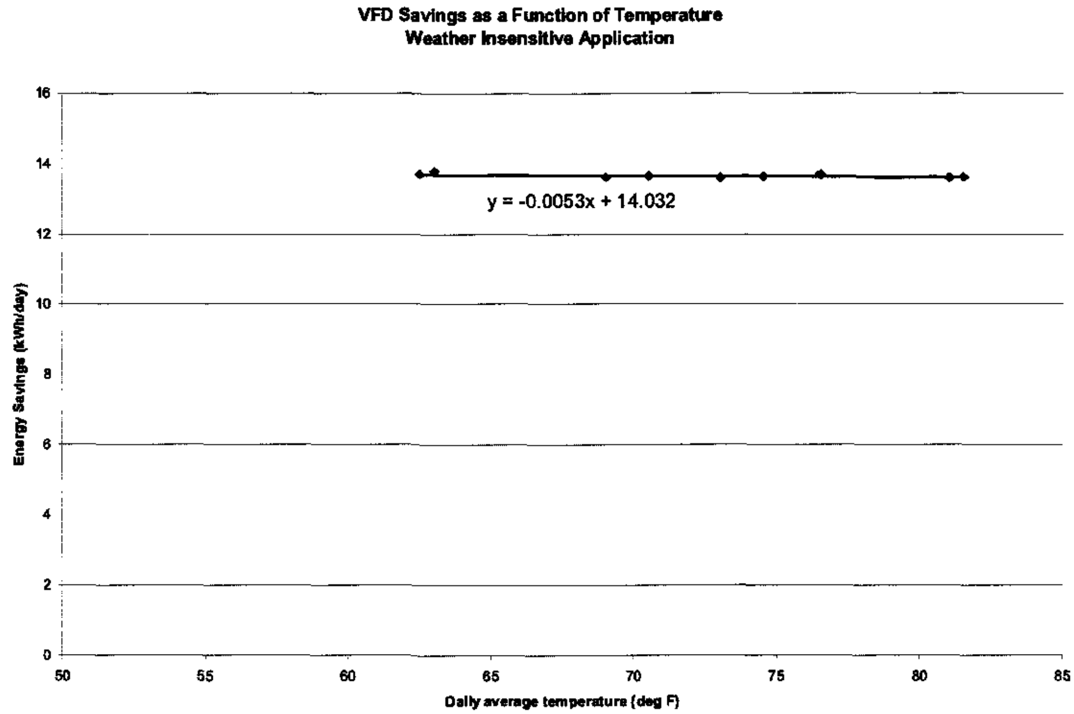


Figure 9. Temperature Independent VFD Energy Savings

Simple linear regression models were developed for the weather sensitive drives. Separate models were developed for weekdays and weekends. These models were used to project the savings per day observed during the monitoring period to annual savings. The long term average weather data for Covington KY were used to develop a distribution of the number of weekday and weekend days at each daily average temperature observed in the weather data record. The workday distribution of daily average temperature is shown in Figure 10.

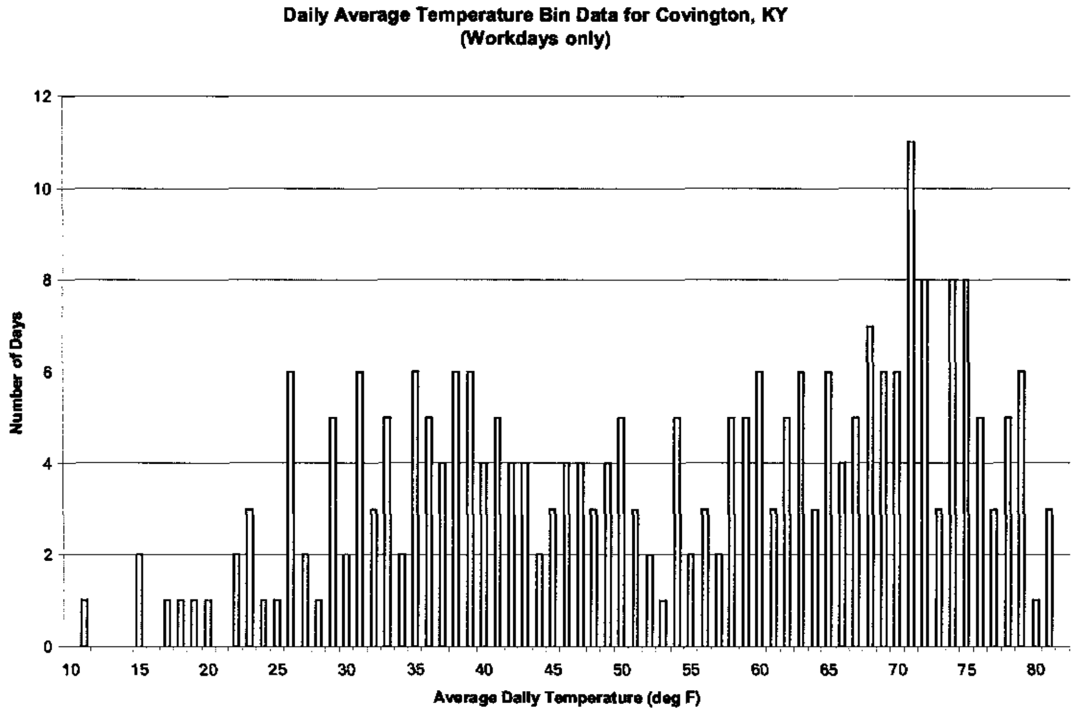


Figure 10. Average Daily Temperature Bin Data for Covington, KY.

The number of days at each daily average temperature bin was combined with the simple regression model of kWh per day savings as a function of day type and daily average temperature to estimate annual energy savings. Drives with non-weather-dependent savings were assigned the average daily savings for each day of the year.

The annual savings for each drive in the study are summarized in Table 22.

Table 22. VFD Gross Energy Savings for Each Sampled Site

Site	Application	Motor hp	Annual kWh/hp
Downtown Office	Exhaust fan / building pressurization control	25	167
Asphalt Plant	Exhauster fan	150	700
Mail sorting facility	Supply fan	20	1,501
Mail sorting facility	Supply fan	20	2,490
Mail sorting facility	Supply fan	20	173
Mail sorting facility	Supply fan	20	588
Mail sorting facility	Return fan	5	1,981
Mail sorting facility	Return fan	5	1,075
Mail sorting facility	Return fan	5	1,876
Mail sorting facility	Return fan	5	994
		Average	**1,154**

Note, the peak demand savings are assumed to be zero for this measure. Full flow at maximum recorded power is a basic assumption in the analysis that yields zero demand savings at peak conditions. This assumption provides conservative estimates of both peak demand and energy savings.

The gross energy and demand impacts per thermostat calculated for the sample is compared to the energy savings per drive used in the program tracking database in Table 23.

Table 23. Comparison of Evaluation vs. Tracking System VFD Savings Estimates

Source	kWh/hp	kW/hp
Tracking database	1,560	0.42
Evaluation	1,154	0.
Realization rate	0.74	0.0

The realization rate for energy savings is 0.74, meaning the evaluation predicted about 74% of the expected savings. Peak demand savings were estimated to be zero.

The realization rates estimated from this evaluation were applied to the VFD savings reported in the program tracking database. The savings for the other motor and pump measures were unadjusted. The total program savings for motors and pumps is shown in Table 24.

Table 24. Motor and Pump Gross Energy and Demand Savings

Measure	kW savings	kWh savings
ODP 1800 1.5 HP	0.24	300
ODP 1800 10 HP	0.13	195
ODP 1800 15 HP	0.17	258
ODP 1800 2 HP	0.03	50
ODP 1800 20 HP	8.28	12,376
ODP 1800 5 HP	2.34	3,622
ODP 1800 7.5 HP	0.11	169
Pump 20 HP	1.51	3,195
TEFC 1200 20 HP	0.36	528
TEFC 1200 30 HP	0.66	998
TEFC 1800 200 HP	1.27	1,910
TEFC 1800 7.5 HP	0.30	439
TEFC 3600 75 HP	0.25	376
VFD HP 1.5	0.00	1,732
VFD HP 10	0.00	11,434
VFD HP 15	0.00	329,173
VFD HP 20	0.00	1,131,892
VFD HP 25	0.00	28,875
VFD HP 3	0.00	27,717
VFD HP 30	0.00	34,650
VFD HP 40	0.00	138,599
VFD HP 5	0.00	297,296

VFD HP 50	0.00	462,003
VFD HP 7.5	0.00	34,650
Total	**15.65**	**2,522,438**

Total Program Gross and Net Impacts

The total program first year gross and net savings are tabulated for lighting, HVAC and Motors and Pumps in Table 25. The net savings are calculated assuming a freeridership level of 42.5% described in Section 3.

Table 25. Total First Year Gross Energy Savings

Measure	Source	First Year Gross kWh	First Year Gross kW
Lighting	Table 13	21,791,830	3,991
HVAC	Table 19	1,618,850	977
Motors and Pumps	Table 24	2,522,438	16
Total First Year Gross Savings		**25,933,118**	**4,984**
Total First Year Net Savings		**14,911,543**	**2,866**

Lifecycle savings were estimated by applying the following effective useful life (EUL) assumptions[5] to each measure.

Table 26. Effective Useful Life for C&I Measures

Measure Type	Measure	EUL (years)
Lighting	Central Lighting Control	12
	CFL-Hardwired Fixture	12
	CFL screw-in	2
	LED traffic and pedestrian signals	7
	LED Exit Signs	15
	Occupancy sensors	8
	Multilevel switching	12
	Linear and High Bay Fluorescent	10
HVAC	Rooftop and Unitary AC and Heat Pumps	15
	Chillers	20
	Programmable thermostats	9
	Window Film	10
Motors and Pumps	Motors	15
	Pumps	15
	VFDs	10

Applying the EUL estimates listed above to each measure, the lifecycle gross and net kWh savings are shown below:

Table 27. Lifecycle Gross and Net Savings for Ohio C&I Program

Result	Value
Lifecycle Gross kWh savings	256,198,405

[5] EUL data supplied by FES

Lifecycle Net kWh savings	147,314,083

Section 3: Freeridership

This section explores freeridership in the C&I program. To estimate freeridership, we spoke with contractors and 37 randomly selected participants. In order to calculate freeridership and apply the estimates to the energy savings, there is a need to consider other factors such as self-selection and false response bias. These biases are discussed below, followed by the freeridership estimates.

Self-Selection and False Response Bias

There are substantial risks associated with relying on self-reported behavioral changes, because the foundation of the savings estimates are based solely on the participant's responses, with no means within the evaluation budget to verify that the respondent has installed the measures and are using them effectively or to document past installation or building/construction records.

There are two main sources of bias with these types of surveys that directly impact the conclusions drawn from the responses. These sources of bias are Self-Selection Bias and False Response Bias. There is also an issue regarding the accuracy of the baseline energy use conditions used by the evaluation contractor to estimate savings in that many of these conditions need to be based on assumptions about the participant population, rather than on measurements. These three conditions significantly impact the evaluation contractor's ability to provide accurate estimates of energy impact. These issues are discussed in more detail in the following paragraphs.

Self-Selection Bias
For this evaluation, we are using the self selection bias value 10% for adjusting freeridership estimates. This value was estimated during a previous evaluation and is considered applicable for the Smart Saver estimate as well. However, to guard against over estimating savings for the program's covered measures we use a more conservative 10% for adjusting freeriders impacts.

Self-Selection Bias
The participant survey effort contacted 119 participants. Of these 66 refused to participate in the survey and 37 completed the survey. This provides a response rate of 45%, a fairly high number for a participant survey. This number indicates that 55% of participants elected not to participate in the survey. These people self-select themselves not to participate in the survey because, for any number of reasons, they are less interested in the subject matter of the contact. That is, they have a bias against the subject of the contact more than those who completed the survey. In this case the respondents are more interested in the subject that those who did not participate and are more likely to have taken the action on their own, than people who are less interested in the subject. As a result we estimate the self-selection to be in the neighborhood of ¼ to ½ the non-response level. In order to not over-estimate savings we are setting the self-selection bias at ¼ off the non-response rate, or about 10%.

False Response Bias
False Response Bias is a problem with many self-reporting surveys. The participants respond not with the truth, but with the socially acceptable answer. In short, for any number of reasons they do not convey the entire story about the reasons for taking an action. In the case of this

program, where the smarter or more self-serving choice is to go with the product that saves money, the bias tends to under-estimate the program as the cause of the action taken. That is, they indicate that they would have taken the action without the program, not necessarily because they would have, but because to report that they would not have made the wise choice without the program makes them appear to be illogical or non-self-serving. In short, it makes them appear to be not very smart. In the field of survey research, questions that make respondents appear to be illogical need to be adjusted for false response bias, often called social acceptance bias. False response bias can typically be as large as 50% or as low as 10%. To guard against over estimating program savings we elected to use a 20% bias adjustment and stay on the lower end of the scale.

Freeridership

We asked the contractors to estimate the level of freeriders. The responses we obtained all centered around a mean score of between 20-80% freeridership for the C&I program. That is, the contractors indicated that about 20% to 80% of their sales are to people who would have purchased the more efficient line without the program rebates with 20% to 80% of sales going to people who have been convinced to move-up to the more efficient line.

The 37 sampled participants indicated a high level of freeridership. Participant responses indicated that about 62.8 percent of sales would have been made without the program. However, this response is not adjusted for survey self selection or for false response bias. Adjusting the survey responses to account for these two biases suggests that the freeridership value is about 45%. This adjustment includes a 10% self selection bias to account for people more interested in energy efficiency to self-select themselves to take the survey and a 20% false response bias.

To arrive at a final freerider estimate we applied the average contactor assessment freerider rate of 42.5%, plus the participant response rate adjusted for self-selection bias (10%) and false response bias of 20% and averaged these two numbers. As a result the final freerider rate is estimated at (42.5 + (62.8 x .9 x .8))/2 or 43.9%. That is, about 43.9% of gross program savings would have been captured by the participants without the program. This estimate represents a reasonable estimate of the net effects adjustment for the estimated gross program savings without conducting on-site verification visits, conducting in-depth interviews with program participants or examining pre-program building and sales records of the participating contactors.

The method used to calculate unadjusted freeridership from survey responses is presented in the table below. Questions are listed in the table in the order they were asked. The first three questions were leading questions to get the participant to think about when they purchased the appliance. The following questions and their responses provided the information to estimate freeridership.

Question	Responses			
At the time that you first heard about the C&I Program from Duke Energy, had you...?	Already been thinking about purchasing a new item	Already begun collecting information about item	Already decided to buy item	Don't Know
Freeridership –>	no effect			

Just to be sure I understand, did you already have specific plans to install a high-efficiency <rebated item> before you heard about Duke's program or their rebate?	Yes	No		Don't Know
Freeridership -->	no effect			
Did you have to make any changes to your existing plans in order to receive this rebate through the C&I Program?	Yes	No		Don't Know
Freeridership -->	no effect			
If the rebate from Duke Energy's C&I Program had not been available, would you still have:	Purchased a new	Purchased the same efficiency of	Purchased the <rebated item> at the same time that you did?	Purchased the <rebated item> earlier than you did, or later? How much <earlier/later>?
Freeridership -->	no = not a FR; yes - move on	no = not a FR; yes - move on	no: 50%; yes: 100%	25% if earlier, FR if later
If the rebate from the C&I Program had not been available, would you have done anything else differently?	Yes	No		Don't Know
Freeridership -->	no effect			
On a 0 to 10 scale, with 0 being not at all likely and 10 being very likely, how likely is it that you would have bought a less efficient <rebated item> if you had not received any rebate from the program?	Scale of 1 to 10			
Freeridership -->	adjust FR down by factor: 1=10% decrease, 2=20% decrease, etc.			
If I had not had any assistance from the program, I would have paid the additional <$200-$600> to buy the <rebated item> on my own?	On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with this statement?			
Freeridership -->	adjust FR up by factor: 1, 2, 3 = not a freerider; 4-7 = 50%; 7 = 70%, 10 = 100% freerider			

The rebate from the Duke Energy S C&I Program was a critical factor in my decision to purchase the high efficiency/energy efficient product.	On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with this statement?
Freeridership -->	adjust FR down by factor: 1, 2, 3 = no change; 4-5 = 10%; 6-8=25%, 9-10 = 50% decrease freerider
I would have bought a <rebated item> within [a year/2 years] of when I did even without the rebate from the Duke Energy C&I Program.	On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with this statement?
Freeridership -->	no effect
The rebate from the Duke Energy C&I Program was not necessary to cause me to purchase the higher efficiency product when I bought my new <rebated item>.	On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with this statement?
Freeridership -->	adjust FR up by factor: 1, 2, 3 = not a freerider; 4-7 = 50%; 7 = 70%, 10 = 100% freerider

Using these responses, freeridership is estimated at 62.8%. However, when the bias adjustments are applied, the value drops to 42.5%, which matches with the estimates provided by the contractors and builders. This is the freeridership level that is applied to the energy savings estimates.

Appendix A: Process Evaluation: Program Manager Interview Protocol

Name: ____

Title: ____

Position description and general responsibilities:

____

____

____

We are conducting this interview to obtain your opinions about and experiences with the Commercial and Industrial Incentive Program. We'll talk about the Program and its objectives, your thoughts on improving the program and its participation rates, and the technologies the program covers. The interview will take about an hour to complete. May we begin?

Program Objectives

1. In your own words, please describe the Commercial and Industrial Incentive Program's objectives.

2. In your opinion, which objectives do you think are being met or will be met? How do you think the program's objectives have changed over time?

3. Are there any program objectives that are not being addressed or that you think should have more attention focused on them? If yes, which ones? How should these objectives be addressed? What should be changed? Do you think these changes will increase program participation?

4. Should the program objectives be changed in any way because of market conditions, other external or internal program influences, or any other conditions that have developed since the program objectives were devised? What changes would you put into place, and how would it affect the objectives?

5. Do you think the incentives application process offered through the C&I Incentive program is easy to understand and complete?

6. Do you think the incentives offered through the program are large enough to entice the C&I community to purchase the high efficiency items? Why or why not?

7. Do you think the incentives cover the right equipment? Do you think there is equipment that is currently incentivized that should not be, or equipment that is not covered that should be?

8. Which measures have been most used?

9. What kinds of marketing, outreach and customer contact approaches do you use to make your customers aware of the program and its options? Are there any changes to the program marketing that you think would increase participation?

10. How do you inform trade allies and contractors about the program? How effective has this been in getting participation from the contractors?

11. Are there any changes to the incentives or marketing that could possibly increase participation in the program?

12. Thinking about how your program enrolls participants, what do you think your level of freeridership is for this program? (*That is, what percent of the equipment rebated through the program would have been purchased and installed without the program's incentive?*)

13. What do you think the level of spillover is for this program? *(That is, what percent of the participants take similar actions in their business that are not rebated through the program?)*

Overall C&I Incentives Management

14. Describe the use of any advisors, technical groups or organizations that have in the past or are currently helping you think through the program's approach or methods. How often do you use these resources? What do you use them for?

15. Overall, what about the Commercial and Industrial Incentive Program works well and why?

16. What doesn't work well and why? Do you think this discourages participation?

17. Can you identify any market or operational barriers that impede a more efficient program operation?

18. If you had a magic wand and could change any part of the program what would you change and why?

Program Design & Implementation

19. What market information, research or market assessments are you using to determine the best target markets or market segments to focus on?

20. What market information, research or market assessments are you using to identify market barriers, and develop more effective delivery mechanisms?

21. How do you manage and monitor or evaluate contractor involvement or performance? What is the quality control and tracking process? What do you do if contractor performance is exemplary or below expectations?

23. In your opinion, did the incentives cover enough different kinds of energy efficient products?

1. ❑ Yes 2. ❑ No 99. ❑ DK/NS

If no, 23b. What other products or equipment should be included? Why?

____

____

24. In what ways can the Commercial and Industrial Incentive Program's operations be improved?

25. Do you have any suggestions for how program participation can be increased?

Appendix B: Draft Contractor Interview Instrument

Commercial and Industrial Incentive Program:
Contractor Interview Instrument

Name: ____

Title: ____

Position description and general responsibilities:

____

____

____

We are conducting this interview to obtain your opinions about and experiences with the Commercial and Industrial Incentive Program. We'll talk about your understanding of the Commercial and Industrial Incentive Program and its objectives, your thoughts on improving the program, and the technologies the program covers. The interview will take about an hour to complete. May we begin?

Understanding the Program

We would like to ask you about your understanding of the C&I Incentive program. We would like to start by first asking you to...

1. Please review for me how you are involved in the program and the steps you take in the participation process. Walk me though the typical steps you take to introduce the program to the customer, and what you do to help a customer become eligible for this program. What do you do to receive or help the customer receive the program incentive?

2. What kinds of problems or issues have come up in the C&I Incentive program?

3. Have you heard of any customer complaints that are in any way associated with this program? Have callbacks increased due to the program technologies?

Program Design and Design Assistance

4. Do you feel that the proper technologies and equipment are being covered through the program?

5. Are the incentive levels appropriate? How do they impact the choice by the customers of the higher efficient equipment?

6. Are there other technologies or energy efficient systems that you think should be included in the program?

7. Are there components that are now included that you feel should not be included? What are they and why should they not be included?

Reasons for Participation in the Program

We would like to better understand why contractors become partners in the C&I Incentive Program.

8. How long have you been a partner in the C&I Incentive Program?

9. What are your primary reasons for participating in the program? Why do you continue to be a partner?.... *If prompts are needed...* Is this a wise business move for you, is it something you believe in professionally, is it that it provides a service to your customers, or other reasons?

10. Has this program made a difference in your business? How? Are your primary reasons for participation being met? Why/why not?

11. How do you think Duke can get more contractors to participate in this program?

Program Participation Experiences

The next few questions ask about the process for submitting participation forms and obtaining the incentive payments.

12. Do you think the process could be streamlined in any way? How?

13. How long does it take between the time that you apply for your incentive, to the time that you and your customer receive the payments? Is this a reasonable amount of time? What should it be? Why?

14. Do you have the right amount of materials such as forms, information sheets, brochures or marketing materials that you need to effectively show and sell the technologies covered by the C&I Incentive Program? What else do you need?

15. Overall, what about the C&I Incentive Program do you think works well and why?

16. What changes would you suggest to improve the program?

17. Do you feel that communications between you and Duke's C&I Incentive program staff is adequate? How might this be improved?

18. What specific benefits do you receive as a result of participating in Duke's C&I Incentive Program or from selling C&I Incentive items?

19. What do you think are the primary benefits to the companies who participate in the C&I Incentive Program?

20. Are there other benefits that are important to a potential customer? What are these?

Market Impacts and Effects

22. How do you make customers aware of the Program?

23. Are customers more satisfied with this equipment? Why or why not?

24. Do you have fewer calls or more calls to correct problems with the C&I Incentive measures?

25. Do you market or sell the Smart Saver equipment differently than your other equipment? How?

26. What percent of your customers end up going to a more efficient product that they would have on their own?

Recommended Changes from the Participating Contractors

27. Are there any other changes that you would recommend to Duke Energy for their Program not already discussed?

28. If you had a magic wand to make any changes you wanted to these programs, what changes would you make to this program?

Standard Practice vs. C&I Incentive Practices

We would like to know what your presentation and sales practices were before your involvement in the C&I Incentive program, and how you would offer your products without the program.

26. If the program were to be discontinued, would you still offer the energy efficient options? If yes, how would you structure pricing differently to make up for the program loss?

27. In your opinion is the C&I Incentive program still needed? Why?

Appendix C: Draft Participant Survey Protocol

The questions below require mostly short, scaled replies from the interviewee, and not all questions will be asked of all participants. This interview should take approximately 10 to 15 minutes.

C&I Incentive Program

Participant Survey

Contact Module
SURVEY INTRODUCTION

If C&I Incentive participant, then contact for survey. Use seven attempts at different times of the day and different days before dropping from contact list. Call times are from 10:00 a.m. to 8:00 p.m. EST or 9-7 CST Monday through Saturday. No calls on Sunday. (Sample size N =50-75)

SURVEY

Introduction

Note: Only read words in bold type.

Hello, my name is ______. I am calling on behalf of Duke Energy to conduct a customer survey about the C&I Incentive Program. May I speak with _____________ please?
If person talking, proceed. If person is called to the phone reintroduce.
If not home, ask when would be a good time to call and schedule the call-back:

Call back 1:	Date: ___________,	Time: ______________	❑AM or ❑PM
Call back 2:	Date: ___________,	Time: ______________	❑AM or ❑PM
Call back 3:	Date: ___________,	Time: ______________	❑AM or ❑PM
Call back 4:	Date: ___________,	Time: ______________	❑AM or ❑PM
Call back 5:	Date: ___________,	Time: ______________	❑AM or ❑PM
Call back 6:	Date: ___________,	Time: ______________	❑AM or ❑PM
Call back 7:	Date: ___________,	Time: ______________	❑AM or ❑PM
	❑ Contact dropped after seventh attempt.		

We are conducting this survey to obtain your opinions about the C&I Incentive Program in which you participated. We are not selling anything. The survey will take about 10-15 minutes and your answers will be confidential, and will help us to make improvements to the program to better serve others. May we begin the survey?

Note: If this is not a good time, ask if there is a better time to schedule a callback.

1. **Do you recall participating in the C&I Incentive Program?**

1. ❑ Yes, *begin* → *Skip to Q3.*
2. ❑ No,
99. ❑ DK/NS

This program was provided through Duke Energy. In this program, your company purchased a new energy efficient motor, pump, HVAC system or component, or lighting system. Duke Energy provided an incentive of <$xxx> for purchasing the qualifying item.

Do you remember participating in this program?

1. ❑ Yes, *begin* → *Go to Q2.*
2. ❑ No,
99. ❑ DK/NS

If No or DK/NS terminate interview and go to next participant.

2. **Our records indicate that you purchased a** <incented item> **Is this correct? If not, what was the rebated technology that you purchased?**

1. ❑ Correct
2. ❑ Pump
3. ❑ Motor
4. ❑ HVAC
5. ❑ Lighting
6. ❑ Refrigeration
7. ❑ Other specify: ____

3. **Please think back to the time when you were deciding to buy the energy saving** <incented item>**, perhaps recalling things that occurred in your company shortly before and after your purchase. What kinds of factors motivated you to purchase energy saving** < incented item>? *(do not read list, place a "1" next to the response that matches best)*

1. ____ Old equipment didn't work
2. ____ Old equipment working poorly

3. ____ The program incentive
4. ____ The program technical assistance
5. ____ Recommendation of someone else (*Probe*: **Who?**__________)
6. ____ Wanted to reduce energy costs
7. ____ The information provided by the Program
8. ____ Past experience with this program
9. ____ Because of past experience with another Duke Energy program
10. ____ Recommendation from other utility program
    i. (*Probe*: **What program?** ________________________)
11. ____ Recommendation of dealer/contractor
12. ____ Advertisement in newspaper (*Probe:* **For what program?** __________)
13. ____ Radio advertisement (*Probe:* **For what program?** __________)
14. ____ Other (SPECIFY) ____
15. ____ Don't know/don't remember/not sure (DK/NS)

If multiple responses: 2.a. **Were there any other reasons?** *(number responses above in the order they are provided - Repeat until 'no' response.)*

5. **Did you get this** < incented item> **to replace an existing** < incented item>**?**

1. ❑ Yes – *skip to question 8*
2. ❑ No
3. ❑ DK/NS – *skip to question 11*

6. **Is this** < incented item> **the first you have ever purchased for your company?**

1. ❑ Yes – *skip to question 11*
2. ❑ No
3. ❑ DK/NS – *skip to question 11*

7. **Did you get this** < incented item> **because you wanted to add another/more** < incented item> **to your facility?**

1. ❑ Yes
2. ❑ No
3. ❑ Don't Know – *skip to question 11*

8. **About how old was the** < incented item> **you replaced?**

1. ❑ Less than 5 years old

2. ❑ 5 to less than 10 years old
3. ❑ 10 to less than 20 years old
4. ❑ 20 years to less than 30 years old
5. ❑ 30 or more years old
99. ❑ Don't Know

9. **Was the old** < incented item> **working or not working?**

1. ❑ Yes, working
2. ❑ No, not working – *skip to question 11*
3. ❑ Don't Know

10. **Was the old** < incented item> **in good, fair, or poor working condition?**

1. ❑ Good
2. ❑ Fair
3. ❑ Poor
4. ❑ Don't Know

Free-Ridership Questions

11. **At the time that you first heard about the C&I Incentive Program from Duke Energy, had you…?**

1. ❑ **Already been thinking about purchasing** < incented item>
2. ❑ **Already begun collecting information about** < incented item> **or**
3. ❑ **Already decided to buy the** < incented item>**?**
4. ❑ Don't Know

12. [illegible]

1. ❑ Yes
2. ❑ No – *skip to question 14*
3. ❑ Don't Know – *skip to question 14*

13. **Did you have to make any changes to your existing equipment replacement plans in order to receive this rebate through the C&I Incentive Program?**

1. ❑ Yes
2. ❑ No
3. ❑ Don't Know

14. **If the rebate from Duke Energy's C&I Incentive Program had not been available, would you still have:**

14a. **Purchased the same type of** < incented item>**?**

1. ❑ Yes
2. ❑ No – *skip to question 16*
3. ❑ Don't Know – *skip to question 16*

14b. **Purchased the same energy efficiency of** < incented item>?

1. ❑ Yes
2. ❑ No
3. ❑ Don't Know

14c. **Purchased the** < incented item> **at the same time that you did?**

1. ❑ Yes – *skip to question 15*
2. ❑ No
3. ❑ Don't Know – *skip to question 15*

14d. **Purchased the** < incented item> **earlier than you did, or later?**

1. ❑ Earlier
2. ❑ Same Time
3. ❑ Later
4. ❑ Don't Know – *skip to question 15*

14e. **How much <earlier/later>?**

1. _________ years and/or _________months
2. ❑ Don't Know

15. **If the rebate from the C&I Incentive Program had not been available, would you have done anything else differently?**

1. ❑ Yes
2. ❑ No
3. ❑ Don't Know

15a. **What would you have done differently?**

____

____

16. **On a 0 to 10 scale, with 0 being not at all likely and 10 being very likely, how likely is it that you would have bought a less efficient** < incented item> **if you had not received any rebate from the program?**

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

I'm going to read several statements about how you came to choose your < incented item>. **On a scale of 0 to 10, where 0 is strongly disagree and 10 is strongly agree, how much do you agree with this statement?**

17. **If I had not had any assistance from the program, I would have paid the additional** <$xxx> **to buy the energy efficient** < incented item> **on my own?**

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

18. **The rebate from the Duke Energy C&I Incentive Program was a critical factor in my decision to purchase the high efficiency/energy efficient product.**

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

19. **I would have bought the same make and model of the** < incented item> **within one year of when I did even without the rebate from the Duke Energy C&I Incentive Program.**

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

20. **The rebate from the Duke Energy C&I Incentive Program was not necessary to cause me to purchase the higher efficiency product when your company bought the new** < incented item>.

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

Consistency Check & Resolution

21 will be asked only for those respondents who have a clear inconsistency between responses (i.e., all but one of the questions are at one end of the spectrum for free ridership while one question is at the other spectrum.) An algorithm will be provided after pretesting. The question responses that will be used to trigger 21 are:

- 14a (only for efficiency enhancement measures)
- 14b (only for incremental efficiency measures)
- 16 depending upon which version of the question they received
- 18
- 19
- 20

21. **Let me make sure I understand you. Earlier, you said** <inconsistency prompted by excel function>**, but that differs from some of your other responses. Please tell me in your own words what influence, if any, the program had on your decision to purchase and install the** < incented item> **at the time you did?**

____
____
____
____

Based on response, correct any above entries.

Spillover Questions

22. **Since you participated in the C&I Incentive Program, have you purchased and installed any other type of high efficiency equipment or made energy efficiency improvements at your company or at any other locations?**

1. ❑ Yes, only at this company
2. ❑ Yes, only at other locations
3. ❑ Yes, at both company and other locations
4. ❑ No
5. ❑ Don't Know

23. **What type and quantity of high efficiency equipment did you install on your own?**
PROBE TO GET EXACT TYPE AND QUANTITY AND LOCATION

Type 1: ________________	Quantity 1: ______	Location 1:____________
Type 2: ________________	Quantity 2: ______	Location 2:____________
Type 3: ________________	Quantity 3: ______	Location 3:____________
Type 4: ________________	Quantity 4: ______	Location 4:____________

24. *For each type listed in 23 above,* **How do you know that this equipment is high efficiency? For example, was it Energy Star rated?**

Type 1: ____
Type 2: ____
Type 3: ____
Type 4: ____

I'm going to read a statement about this equipment that you purchased on your own. On a scale from 1-10, with 0 indicating that you strongly disagree, and 10 indicating that you strongly agree, please rate the following statement.

25. **My experience with the C&I Incentive Program in** <2006, 2007, 2008> **influenced my decision to install different types of high efficiency equipment on my own.**

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

26. **What other actions, if any, have you taken in your company to save energy and reduce utility bills as a result of what you learned in this program?**
Response:1 ____
Response:2 ____
Response:3 ____
Response:4 ____

Now I am going to ask you some general satisfaction statements. On a scale from 1-10, with 0 indicating that you strongly disagree, and 10 indicating that you strongly agree, please rate the following statements.

27. **The rebate form was easy to understand and complete.**

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

If 7 or less, **How could this be improved?**______________________________

____

28. **The interactions and communications I had with Duke Energy staff was satisfactory.**

1 2 3 4 5 6 7 8 9 10

❑ Not applicable

If 7 or less, **How could this be improved?**____

____

30. **Overall I am satisfied with the program.**

1 2 3 4 5 6 7 8 9 10

❑ Don't Know

If 7 or less, **How could this be improved?**____

____

31. **What additional services would you like the program to provide that it does not now provide?**

Response: ____

____

32. **Are there any other things that you would like to see changed about the program?**

Response: ____

33. **What do you think can be done to increase people's interest in participating in the C&I Incentive Program?**

Response:1 ____

Response:2 ____
Response:3 ____
Response:4 ____

34. **What do you like most about this program?**

Response: ____

35. **What do you like least about this program?**

Response: ____

Appendix D: Prototype Building Model Descriptions

Small Retail Prototype

A prototypical building energy simulation model for a small retail building was developed using the DOE-2.2 building energy simulation program. The characteristics of the small retail building prototype are summarized in Table 28.

Table 28. Small Retail Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	6400 square foot sales area 1600 square foot storage area 8000 square feet total
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-11
Roof construction and R-value	Wood frame with built-up roof, R-19
Glazing type	Single pane clear
Lighting power density	Sales area: 3.4 W/SF Storage area: 0.9 W/SF
Plug load density	Sales area: 1.2 W/SF Storage area: 0.2 W/SF
Operating hours	10 – 10 Monday-Saturday 10 – 8 Sunday
HVAC system type	Packaged single zone, no economizer
HVAC system size	Sales floor: 240 SF/ton Storage area: 380 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the small retail building prototype is shown in Figure 11.

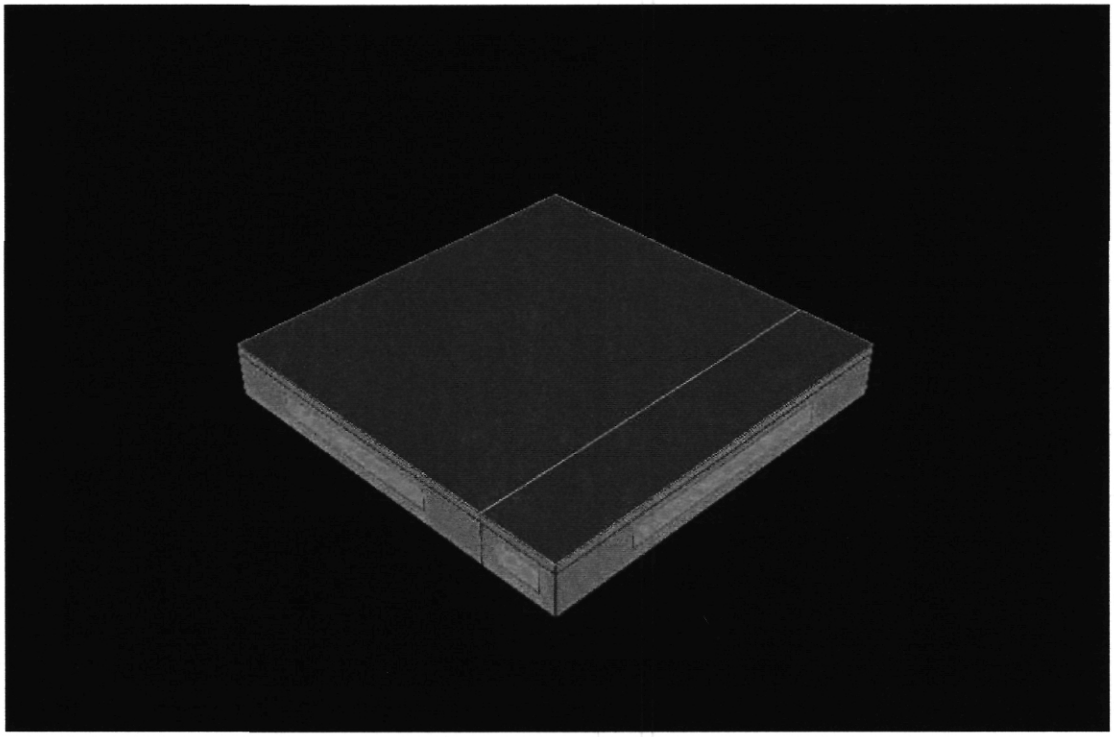


Figure 11. Small Retail Prototype Building Rendering

Full-service Restaurant Prototype

A prototypical building energy simulation model for a full-service restaurant was developed using the DOE-2.2 building energy simulation program. The characteristics of the full service restaurant prototype are summarized in Table 29.

Table 29. Full Service Restaurant Prototype Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	2000 square foot dining area 600 square foot entry/reception area 1200 square foot kitchen 200 square foot restrooms
Number of floors	1
Wall construction and R-value	Concrete block with brick veneer, R-11
Roof construction and R-value	Wood frame with built-up roof, R-19
Glazing type	Single pane clear
Lighting power density	Dining area: 1.7 W/SF Entry area: 2.5 W/SF Kitchen: 4.3 W/SF Restrooms: 1.0 W/SF
Plug load density	Dining area: 0.6 W/SF Entry area: 0.6 W/SF

	Kitchen: 3.1 W/SF Restrooms: 0.2 W/SF
Operating hours	9am – 12am
HVAC system type	Packaged single zone, no economizer
HVAC system size	Dining area: 150 SF/ton Entry area: 90 SF/ton Kitchen: 220 SF/ton Restrooms: 190 SF/ton
Thermostat setpoints	Occupied hours: 77 cooling, 72 heating Unoccupied hours: 82 cooling, 67 heating

A computer-generated sketch of the full-service restaurant prototype is shown in Figure 12.

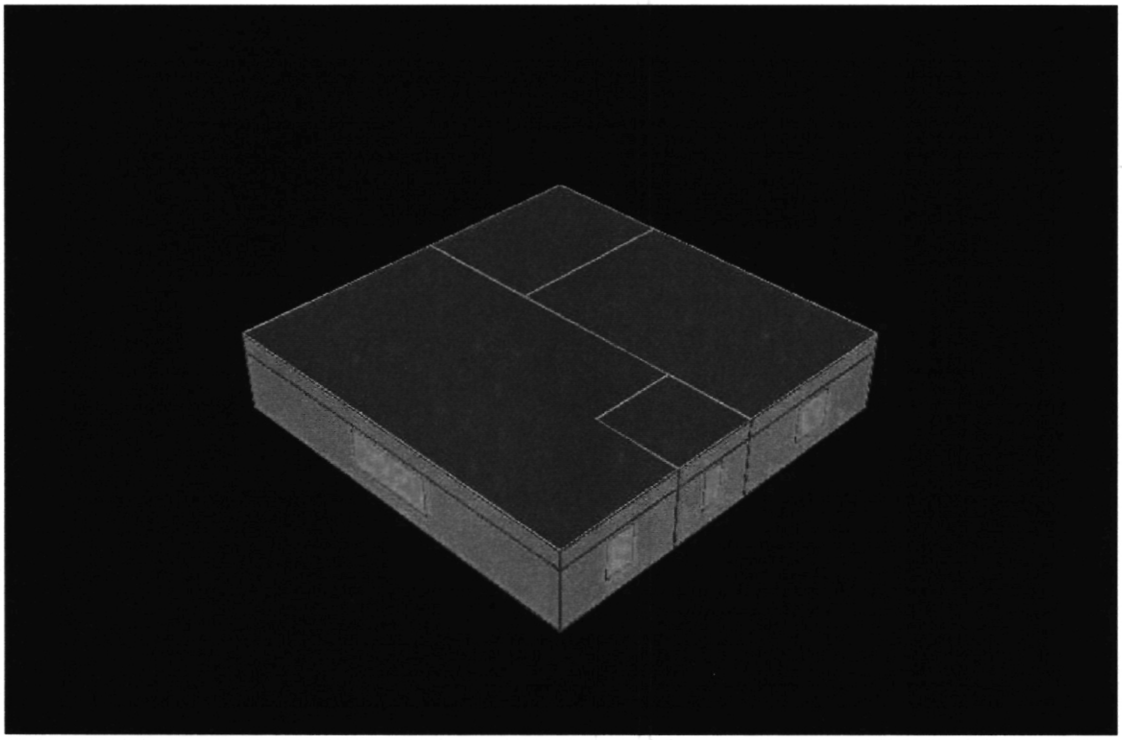


Figure 12. Full Service Restaurant Prototype Rendering

Assembly

A prototypical building energy simulation model for an assembly building was developed using the DOE-2.2 building energy simulation program. The characteristics of the prototype are summarized in Table 30.

Table 30. Assembly Prototype Building Description

Characteristic	Value
Vintage	Existing (1970s) vintage
Size	34,000 square feet Auditorium: 33,240 SF Office: 760 SF
Number of floors	1

Wall construction and R-value	Concrete block, R-7
Roof construction and R-value	Wood frame with built-up roof, R-14
Glazing type	Double pane clear
Lighting power density	Auditorium: 3.4 W/SF Office: 2.2 W/SF
Plug load density	Auditorium: 1.2 W/SF Office: 1.7 W/SF
Operating hours	Mon-Sun: 8am – 9pm
HVAC system type	Packaged single zone, economizer on units ≥ 135,000 Btu/hr cooling
HVAC system size	100 SF/ton
Thermostat setpoints	Occupied hours: 76 cooling, 72 heating Unoccupied hours: 81 cooling, 67 heating

A computer-generated sketch of the prototype is shown in Figure 13.

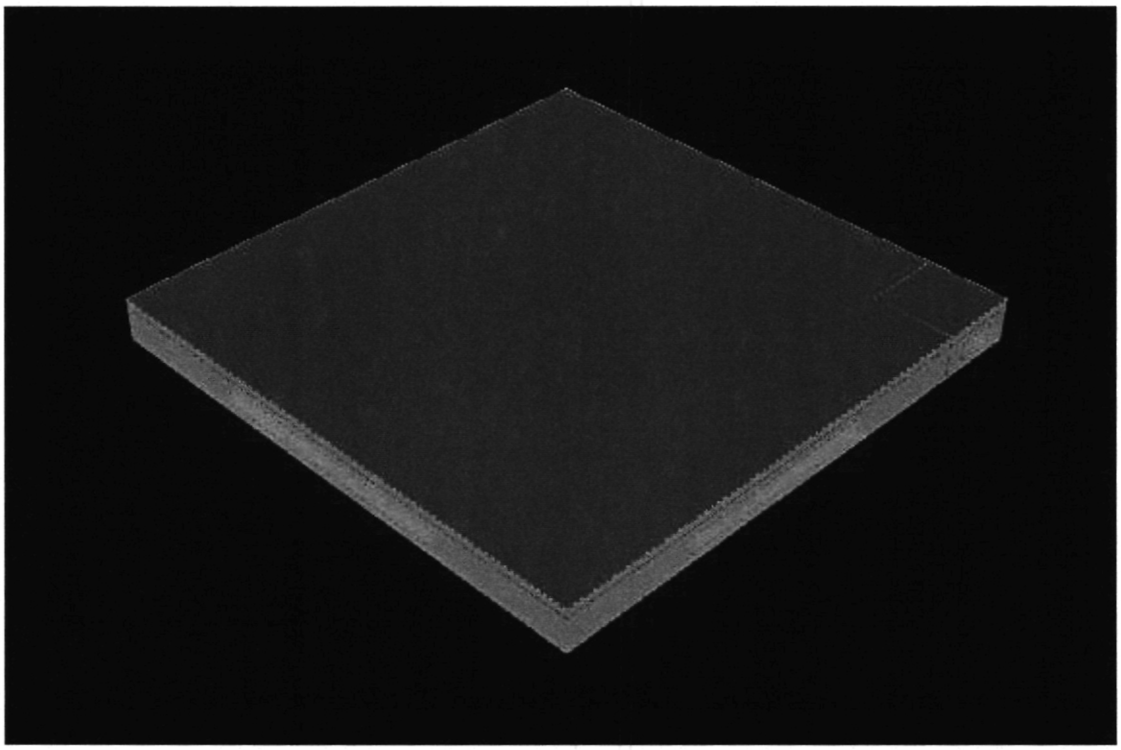


Figure 13. Assembly Building Rendering

Technology

Vending Equipment Controls

The most prevalent and available control is Bayview Technology's (owned by US Technologies, Inc) VendingMiser. There are companies that produce controls that are more integrated into the equipment, which may reduce or eliminate tampering or disconnection of measure, but would face potential installation and bottler resistance/ obstacles.

Energy Savings – kWh

Typical vending equipment consumes 7-14 kWh/day depending on size.
VendingMiser claims savings range is from 30%-50%
Potential annual energy saving calculate between 766.5 and 2,555 kWh per unit/year.
Tufts Climate initiative estimated 1752 kWh/year savings (see attached) based on a very limited study.

We have had experience with the installation of thousands of these units on programs over the last couple of years. We feel the units are effective in some applications but misapplications and persistency lead us to savings on the low end of expectations. We recommend assuming a savings level of 800 kWh/year.

Summer Peak Savings

N/A – same as above

Measure Life

Questions about persistence have been raised because the units are easily accessed and removed or unplugged. Position of sensor is also important for optimum performance. Although the quality of the product will allow for a longer life, we have assumed 5 years, as with other plug load technologies, analyzed, due to the persistency issue.

Initial One-Time Cost

Prices vary primarily due to institutional rates that are available to Utility and Government conservation programs. Identified costs vary from $140 to $180 per unit.

Any Recurring Costs

Re-enforcement and training (see Tufts University document)

Suggested Incentive

Rebates from throughout the US range from $30 - $120 per unit (see attached list). Rebates vary/varied from "limited time" to "limited number" offers. Incentives are appealing due to 'ease of implementation' and management. Incentives in the upper half of the range specified can lead to paybacks from months to under two years. We recommend a $30 incentive be considered.

Requirements

May need to move equipment away from the wall to access the outlet. Should follow placement of sensor directions closely. (see Tufts University document attached)

Existing Energy Standards

None, for the controls. There are pending Energy Star standards for the vending equipment. (see attached; comments on pending standards by Bayview Technologies also included)

Source of Info

Bayview Technologies; EPA Energy Star; multiple utility/government program sites; Tufts University

Technology

High Performance Windows and Window Films

Please note the information provided is generally on a square footage basis.

Energy Savings – kWh & Summer Peak Savings

The benefit of, and motivation for, providing incentives on window technologies varies considerable depending on region and perspective regarding heating and cooling. Since Cinergy is an electric only provider in Indiana, we strictly looked at the benefits to cooling load. With this perspective the key window or window film characteristic becomes the solar heat gain coefficient (SHGC). The lower the factor, the lower the heat gain, the greater the air conditioning savings. The coefficient is a number from 0 to 1 that basically corresponds to the percentage of heat that is allowed into the conditioned space.

The analysis would be significantly more complicated if we attempted to consider electric space heat and the importance of the window/glass U-factor and infiltration rates.

Windows	10 kWh/square foot/year
Window Film	12 kWh/square foot/year

Window savings are discounted slightly from window film. We have assumed that window films are added more often to high heat gain windows and new or replacement window installations are done uniformly around a building. The improvement in the SHGC is assumed to be similar for new windows and window film.

Measure Life

New windows should conservatively last 20 to 30 years. The life of window films is assumed to be less because post manufacturing installations of coatings may not last as long and they are generally installed on older, existing windows that would inherently have a shorter remaining life than a new window.

Windows	20 years
Window Film	10 years

Initial One-Time Cost

Windows – $25 to $100 per square foot depending on complexity, features and difficulty of installation. Analysis assumes $60 per square foot.

Window films – costs are in the $3 to $9 per square foot range. Analysis assumed $6 per square foot.

Any Recurring Costs

None

Suggested Incentive

Windows – No incentive is recommended because we feel that incentives that can be reasonably afforded will not impact the purchase decision. The potential air conditioning savings is a very low percentage of the cost of a window, thus for replacement windows, we are assuming air conditioning savings are not a critical component of the decision making process. For new windows the incremental cost of a window that reduces heat gain may be a factor but still likely outweighed by other issues such as location (low SHGC most helpful on south and west exposures), aesthetics, U-factor and other window features.

Window films: $.25/ft^2$

We feel incentives can impact decision making process on reflective window film applications. The lower cost, compared to new windows, results in shorter paybacks, indicating decisions for energy efficiency reasons, not others like aesthetics and condition of existing units.

Requirements

A maximum SHGC of .40 after window film application. Application must improve overall SHGC by at least .10.

Existing Energy Standards

No meaningful standard. The variability of window location, orientation to the sun, U-factors, SHGC, Visible Transmittance and other variables make establishing a standard very difficult.

Source of Info

Efficient windows collaborative, various manufacturer websites and utility websites

Technology

Plug Load Occupancy Control

Energy Savings – kWh

Computer Monitors	Continuous Use	50 to 80 watts	
	Standby Mode	0 to 12 watts	Avg. Est. = 8 watts.
Computer	Continuous	55 to 75 watts	
	Energy Saver Mode	20 to 30 watts	
Lighting	1 lamp 18" T-8 or T-12 magnetic/std	19 watts	
	2 lamp 18" T-8 or T-12 magnetic/std	36 watts	
	1 lamp 24" T-8 or T-12 magnetic/std	26 watts	
	2 lamp 24" T-8 or T-12 magnetic/std	52 watts	
	1 lamp 36" T-8 or T-12 magnetic/std	46 watts	
	1 lamp 24" T-8 electronic	16 watts	
	2 lamp 24" T-8 electronic	31 watts	Avg. Est. = 30 watts
Laser Printers	Continuous Use	130 to 550 watts	
	Idle Use	10 to 125 watts	Avg. Est. = 50 watts
Copiers	Continuous Use	400 to 1100 watts	
	Idle Use	20 to 300 watts	Avg. Est. = 120 watts
Fax, stamp machine, scanner etc.	Idle Use or Energy Saver Mode		Avg. Est. = 50 watts

Savings per work area – Assume only monitor and lighting left on in 25% of areas for an average of 10 hours/day (including weekends)

$$\frac{(8 \text{ watts} + 30 \text{ watts}) \times 10 \text{ hours/day} \times 365 \text{ days/year} \times .25}{1000 \text{ watts/kWh}} = 139 \text{ kWh}$$

Savings per document station

$$\frac{(50 + 120 + 50) \times 10 \text{ hours/day} \times 365 \text{ days/year} \times .25}{1000 \text{ watts/kWh}} = 803 \text{ kWh}$$

Please note that work station savings could be significantly greater with assumption of additional loads (fans, heaters, radios, etc) or increase in 25% savings factor.

Summer Peak Savings

Assume reduction only during unoccupied periods.

Measure Life

5 years. Occupancy control equipment will likely last longer but measure life reduced because of probability of bypass or non-use because some versions of this technology are not hard wired.

Initial One-Time Cost

Vary widely from low of $80 for single office/cubicle or document station occupancy sensor with plug load powerstrip. Outlets wired to a separate switch (i.e. – no rewiring) can also provide for installations below $100.

Cost in new construction to wire outlets separate from computer circuit is also a modest and highly variable cost ($50 to $250). Could tie control into lighting circuit and sensor to enhance economics.

Controls companies and some office cubicle manufacturers are offering "Personal Environmental Modules" which are individual space controls. Cost usually several hundred dollars and up.

Several hundred dollar cost likely for rewiring on document stations and individual work spaces without proper circuitry or where plug load powerstrip and occupancy sensor don't work.

Based on above, assume $150 average cost although variable from $80 to $400+.

Any Recurring Costs

None

Suggested Incentive

$15/work station (Individual office or cubicle)
$40/central document station (Multi user area with fax, copier, printer, etc.)

It's possible that document station can be controlled by a single power strip with sensor at a cost of $80 to $100 which would result in a high percentage incentive.

Requirements

Control of at least two devices in workstation (task lighting, monitor, printer, fax, space heater, fan, etc)

Control of at least three devices in central document station

Advise against controlling computers with occupancy control.

Existing Energy Standards

None Found

Source of Info

June 2000 ASHRAE Journal Study, 2001 ASHRAE Fundamentals, manufacturers websites

Technology

Light Tube Commercial Skylight.

This technology is essentially a 10" to 21" diameter skylight with a prismatic or translucent lens that reflects light captured from a roof opening through a highly specular reflective tube down to the mounted fixture height. When in use, a light tube fixture resembles a metal halide fixture. Uses include grocery, school, retail and other single story commercial buildings.

Estimated Energy Savings – kWh

As noted on the following table, the average savings is calculated to be 361 kWh. Please note, this assumes only 21" and 14" installations.

Brand/size	Lumen Output	Equivalent	KW	kWh
Solatube 21"	13,500-20,500	2-3LF32T8 172W	0.172	481.6
14"	6000-9100	1-3LF32T8	0.086	240.8
10"	3000-4600	3-18W quad	0.054	151.2

2800 hours per year used for savings calculations. Manufacturers maintain that light overcast conditions still allow for adequate output to offset electric light use.

Summer Peak Savings

There would be a fairly high correlation between sunlight available for the light tube and summer peak demand. Using 90% of the 0.129 KW average shown above results in a demand reduction estimate of 0.116 KW.

Measure Life

Warranty is 10 years. We have assumed a 14 year average life.

Initial One-Time Cost

Do it yourself kits range in price from approximately $300 to $500. Labor to install varies (approx. $200-$400) based on the type of roof deck. Average cost assumed to be on the low end, $500. Unless installations are easy and straightforward we don't feel many customers will utilize this technology. New construction installations are less expensive, and likely more viable.

Any Recurring Costs

Flashing may need occasional maintenance and lens many need cleaning.

Suggested Incentive

California Commercial Skylight program offers $56 for each installed 21" Solatube skylight. California incentives tend to be fairly high on a cost per kWh basis. This technology appears to have a relatively low savings level compared to the cost thus an extensive incentive is difficult to justify. We recommend using $25 for the analysis. We see this as most cost effective in the new construction market where installation costs are lower and planning and design can maximize savings.

Requirements

Commercial and Industrial interior spaces that would otherwise require electric lighting between 1-4PM on weekdays during the summer to reduce peak demand.

Existing Energy Standards

There are currently no standards for this technology.

Source of Info

California Energy Commission website www.energy.ca.gov, www.evsolar.com/daylighting.htm, www.elitesolarsystems.com, www.Solatube.com/solamaster.htm , www.dayliteco.com, PG&E Daylighting McDonald's case study, manufacturer's web sites,

Technology

Window and Through-the Wall AC Units (w/ louvers & w/o louvers). Please note units with louvers are window units with more heat exchanger surface on sides of units. Units without louvers are units installed in a sleeve with outside exposure only to front, not sides of unit.

Energy Savings – kWh & Summer Peak Savings

Savings are based on number of full load cooling hours. The tables below show savings for both 700 and 900 full load hours. Energy savings were calculated using the ENERGY STAR website's on-line calculator. CEE states that savings are greater than what ENERGY STAR predicts. Peak Savings are difference between ENERGY STAR product and Federal Standard product and can be multiplied by utility diversification factor.

700 full load cooling hours				
Equipment (Btu/h)	**ENERGY STAR, w/ louvers kWh Savings**	**ENERGY STAR w/ louvers kW Savings**	**ENERGY STAR, w/o louvers kWh Savings**	**ENERGY STAR w/o louvers kW Savings**
< 6,000	40	0.1156	42	0.1212
6,000 to 7,999				
8,000 to 13,999	66	0.1134	126	0.1352
14,000 to 19,999	108	0.1156		
≥ 20,000	189	0.1747		
900 full load cooling hours				
Equipment (Btu/h)	**ENERGY STAR, w/ louvers kWh Savings**	**ENERGY STAR w/ louvers kW Savings**	**ENERGY STAR, w/o louvers kWh Savings**	**ENERGY STAR w/o louvers kW Savings**
< 6,000	52	0.1156	55	0.1212
6,000 to 7,999				
8,000 to 13,999	85	0.1134	162	0.1352
14,000 to 19,999	139	0.1156		
≥ 20,000	243	0.1747		

The following estimates are provided assuming 800 hours and a mix of sizes.

- w/Louvers under 14,000 Btu/hr; 70kWh and .114 KW
- w/Louvers 14,000 Btu/hr and over; 185 kWh and .151 KW
- w/o Louvers under 14,000 Btu/hr; 80 kWh and .121 KW
- w/o Louvers 14,000 Btu/hr and over; 190 kWh and .16 KW
-

Measure Life

10-12 years

Initial One-Time Cost

Increased costs vary by manufacturer, but average around $70 for units 12,500 Btu/h and smaller $100 per unit for larger units.

Any Recurring Costs

None

Suggested Incentive

According to Consumer Reports, much of the Northeast is offering a $25 rebate for an ENERGY STAR model, and $50 in California. An incentive of around $25 for smaller units is the highest we would recommend given the size of the savings. A second level of incentive at $40 for larger units could be considered.

Requirements

For Application – EER requirements are listed in the table below.
Size – The ENERGY STAR website, the FEMP website, and the CEE website offer guidelines for properly sizing a window AC unit. Proper sizing can save more energy than upgrading to an ENERGY STAR model.

Existing Energy Standards

There is currently an ENERGY STAR standard for this product. ENERGY STAR standards are divided based on whether the units have side louvers, with standard and casement window units having louvers, and through-the wall units not having louvers. The following table lists the ENERGY STAR standards.

<table>
<tr><th>Equipment (Btu/h)</th><th>Federal EER, w/ louvers</th><th>ENERGY STAR EER, w/ louvers</th><th>Federal EER, w/o louvers</th><th>ENERGY STAR EER, w/o louvers</th></tr>
<tr><td>< 6,000</td><td rowspan="2">≥ 9.7</td><td rowspan="2">≥ 10.7</td><td rowspan="2">≥ 9.0</td><td rowspan="2">≥ 9.9</td></tr>
<tr><td>6,000 to 7,999</td></tr>
<tr><td>8,000 to 13,999</td><td>≥ 9.8</td><td>≥ 10.8</td><td rowspan="3">≥ 8.5</td><td rowspan="3">≥ 9.4</td></tr>
<tr><td>14,000 to 19,999</td><td>≥ 9.7</td><td>≥ 10.7</td></tr>
<tr><td>≥ 20,000</td><td>≥ 8.5</td><td>≥ 9.7</td></tr>
</table>

Source of Info

Energy Star website; Prices from Consumer Reports website; CEE; FEMP; manufacturers web sites

1	4	6	7	8				12		
			Impacts per Measure		INDIANA Indianapolis	OH/KY Covington	CAR weighted			
Non Residential Programs/Measures	Incremental Measure Customer Cost	Customer incentive Per Unit	Annual kWh Impact	kW Impact	Annual kWh Impact	Annual kWh Impact	Annual kWh Impact	Measure Life		
Prescriptive Measures										
Lighting										
1 Lamp T-5 HO with Elec Ballast replacing T-12	$ 120.00	$ 6.00	96	0.015				10		
1 Lamp T-5 with Elec Ballast replacing T-12	$ 59.30	$ 5.00	50	0.012				10		
2 Lamp T-5 replacing T-12	$ 74.12	$ 8.00	50	0.012				10		
2 Lamp T-5HO replacing T-12	$ 140.00	$ 9.00	196	0.068				10		
3 Lamp T-5 replacing T-12	$ 79.50	$ 10.00	112	0.027				10		
3 Lamp T-5HO replacing T-12	$ 175.00	$ 11.00	262	0.063				10		
4 Lamp T-5 replacing T-12	$ 87.56	$ 12.00	100	0.024				10		
4 Lamp T-5HO replacing T-12	$ 223.88	$ 13.00	191	0.212				10		
42W 8 Lamp Hi Bay CFL	$ 395.00	$ 50.00	470	0.083				10		
CFL Fixture	$ 45	$ 22.00	368	0.03				12		
CFL Screw in	$ 5	$ 2.00	178	0.031				2		
Hi Bay 4LT5HO	$ 192.00	$ 50.00	892	0.212				10		
Hi Bay Fluorescent 6LF32T8	$ 160.00	$ 50.00	961	0.231				10		
High Bay 2L T5HO	$ 180.00	$ 30.00	458	0.1				10		
High Bay 5L T5HO	$ 350.00	$ 60.00	1227	0.3				10		
High Bay 8L T5HO	$ 350.00	$ 75.00	2620	0.53				10		
High Bay Flourescent 8LF32T8	$ 200.00	$ 60.00	1215	0.292				10		
High Bay Fluorescent 4LF32T8	$ 160.00	$ 40.00	491	0.118				10		
LED Auto Traffic Signals	$ 50	$ 12.50	275	0.07				6		
LED Exit Signs Electronic Fixtures (Retrofit Only)	$ 25.00	$ 12.00	158	0.009				16		
LED Pedestrian Signals	$ 100	$ 26.00	150	0.044				8		
Light Tube	$ 500	$ 125.00	361	0.1				14		
Occupancy Sensors over 500 Watts	$ 200	$ 40.00	1069	0.29				12		
Occupancy Sensors under 500 Watts	$ 100	$ 20.00	427	0.12				12		
Plug Load Occupancy Sensors Document Stations	$ 150	$ 25.00	803	0.091				5		
Pulse Start Metal Halide (retrofit only)	$ 150	$ 25.00	430	0.113				7		
T-8 2ft 1 lamp	$ 58.43	$ 3.00	29	0.01				10		
T-8 2ft 2 lamp	$ 82.86	$ 4.00	71	0.002				10		
T-8 2ft 3 lamp	$ 109.29	$ 4.20	100	0.017				10		
T-8 2ft 4 lamp	$ 114.72	$ 8.00	171	0.007				10		
T-8 3ft 1 lamp	$ 56.80	$ 3.00	46	0.011				10		
T-8 3ft 2 lamp	$ 83.20	$ 4.00	42	0.01				10		
T-8 3ft 3 lamp	$ 109.80	$ 6.50	50	0.012				10		
T-8 3ft 4 lamp	$ 115.40	$ 10.00	83	0.02				10		
T-8 4ft 1 lamp	$ 63.84	$ 3.00	58	0.016				10		
T-8 4ft 2 lamp	$ 77.38	$ 4.00	71	0.019				10		
T-8 4ft 3 lamp	$ 82.37	$ 9.00	133	0.034				10		
T-8 4ft 4 lamp	$ 147.51	$ 11.00	158	0.04				10		
T-8 8ft 1 lamp	$ 137.43	$ 5.00	46	0.001				10		
T-8 8ft 2 lamp	$ 146.56	$ 7.00	83	0.02				10		
T-8 HO 8 ft 1 Lamp	$ 146.55	$ 10.00	104	0.05				10		
T-8 HO 8 ft 2 Lamp	$ 184.80	$ 14.00	209	0.06				10		
Motors/Pumps/VFD										
High Efficiency Pumps HP 5	$ 341	$ 100.00	379	0.100				15		
Motors 1-5 HP - Incentives per participant	$ 93	$ 30.00	95	0.03				15		
Motors 26-100 HP - Incentives per participant	$ 707	$ 275.00	775	0.29				15		
Pumps [illegible]	$ 332	$ 200.00	756	0.210				15		
Pumps HP [illegible]	$ 585	$ 250.00	1135	0.310				15		
Pumps HP 20	$ 850	$ 300.00	1513	0.410				15		
Pumps HP 7.5	$ 498	$ 150.00	567	0.150				15		
Variable Frequency Drive Pumps HP 5	$ 1,061	$ 2,176.50	14,197	0.027	16,418	10,202	10,196	15	VFD applied to chilled	5.00
VFD HP 1.5	$ 318	$ 60.00	4,259	0.01	3,124	3,060	3,091	15	VFD applied to chilled	1.50
VFD HP 10	$ 2,123	$ 2,964.00	28,394	0.054	20,835	20,403	20,210	15	VFD applied to chilled	10.00
VFD HP 15	$ 3,184	$ 3,560.50	42,590	0.082	31,239	30,605	30,314	15	VFD applied to chilled	15.00
VFD HP 2	$ 425	$ 80.00	5,679	0.01	4,165	4,081	4,042	15	VFD applied to chilled	2.00
VFD HP 20	$ 4,246	$ 4,030.50	56,787	0.109	41,650	40,806	40,419	15	VFD applied to chilled	20.00
VFD HP 25	$ 5,307	$ 4,705.50	70,984	0.136	52,063	51,008	50,524	15	VFD applied to chilled	25.00
VFD HP 3	$ 637	$ 120.00	8,518	0.02	6,248	6,121	6,063	15	VFD applied to chilled	3.00
VFD HP 30	$ 6,369	$ 5,414.00	85,181	0.163	62,475	61,210	60,629	15	VFD applied to chilled	30.00
VFD HP 40	$ 8,492	$ 5,685.00	113,574	0.218	83,300	81,613	80,839	15	VFD applied to chilled	40.00
VFD HP 50	$ 10,615	$ 7,128.00	141,968	0.272	104,125	102,016	101,048	15	VFD applied to chilled	50.00
VFD HP 7.5	$ 1,592	$ 2,751.50	21,295	0.041	15,619	15,302	15,157	15	VFD applied to chilled	7.50
Other Prescriptive Measures										
80Plus NC_Desktop Unit	$ 10	$ 5.00	65	0.016				4		
80Plus NC_Server Unit	$ 5	$ 10.00	301	0.034				4		
Barrel Wraps (Inj Mold & Extruders)	$ 2	$ 1.00	50	0.010				5		
Commercial Clothes Washers - Electric Dryer & Washer	$ 325	$ 50.00	950	0.260				11		
Commercial Clothes Washers - Washer Only	$ 325	$ 50.00	400	0.090				11		
Engineered Nozzles - COMPRESS AIR	$ 80	$ 20.00	7343	3.680				15		
Head Pressure Control	$ 51	$ 60.00	1447	0.000	1,600	1,607	1,871	15	per ton	
HP Water Heater 1000 gal_day	$ 10,000	$ 5,000.00	43,637	11.84				8		
HP Water Heater 1500 gal_day	$ 14,000	$ 7,000.00	65,639	17.81				8		
HP Water Heater 500 gal_day	$ 7,000	$ 3,500.00	21,635	5.87				8		
Night covers for displays	$ 38	$ 25.00	21	-0.001	27	24	23	15	per LF of case	
Pellet Dryer Tanks & Ducts 3in dia	$ 33	$ 12.00	99	0.02				5		
Pellet Dryer Tanks & Ducts 5in dia	$ 54	$ 23.00	175	0.04				5		
Pellet Dryer Tanks & Ducts 8in dia	$ 66	$ 40.00	304	0.06				5		
Setback_Programmable Thermostat	$ 100	$ 50.00	1,138	-0.043	1,187	1,139	1,421	9	per tstat	
Vending Equipment Controller	$ 160	$ 50.00	800	0.220				5		
Window Film	$ 2	$ 2.00	5	0.003	7	12	8	10	Per SF	
Zone Shutoff Valves -COMPRESSED AIR	$ 472	$ 236.00	1141	0.310				10		
Energy Star Food Service Products										
Combi Oven, (90 lbs_hr)	$ 12,000.00	$ 1,000.00	17000	4.21				10		
Conv Oven	$ 2,700.00	$ 260.00	2665	0.50				10		

Non Residential Programs/Measures	Indianapolis		Covington		Asheville		Charlotte	
Variable Frequency Drive Pumps HP 5	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 1.5	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 10	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 15	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 2	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 20	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 25	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 3	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 30	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 40	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 50	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
VFD HP 7.5	2814.199	0.086	2757.187	0.190	2676.344	0.083	2740.683	0.101
Head Pressure Control	1600.366	0.000	1607.082	0.000	1645.670	0.000	1321.963	0.000
Night covers for displays	27.060	-0.007	24.060	-0.006	24.853	0.000	22.668	0.000
Setback_Programmable Thermostat	1307.902	-0.106	1,287	-0.021	1071.443	-0.107	1700.237	-0.102
Window Film	652.411	0.273	1190.519	0.636	466.663	0.163	666.521	0.286
Combi Oven, (90 lbs_hr)			1,139	-0.043				

Fryer	$ 4,700.00	$ 200.00	1200	0.23				10
Griddles	$ 4,000.00	$ 260.00	1920	0.40				10
Holding Cabinet Full Size Insulated	$ 1,200.00	$ 260.00	4,600	0.65				12
Holding Cabinet Half Size Insulated	$ 1,200.00	$ 150.00	1700	0.40				12
Holding Cabinet Three Quarter Size Insulated	$ 1,200.00	$ 200.00	2400	0.50				12
Icemaker, (100 to 500 lbs_day)	$ 600.00	$ 100.00	905	0.20				10
Icemaker, (500 to 1000 lbs_day)	$ 1,500.00	$ 200.00	1805	0.40				10
Icemaker, (Greater Than 1000 lbs_day)	$ 2,000.00	$ 300.00	2700	0.52				10
Solid Door Reach-in Freezer, (19 to 60 cu ft)	$ 400.00	$ 75.00	480	0.13				12
Solid Door Reach-in Freezer, (Greater Than 60cu ft)	$ 700.00	$ 125.00	1080	0.22				12
Solid Door Reach-in Freezer, (Less Than19 cu ft)	$ 150.00	$ 50.00	240	0.06				12
Solid Door Reach-in Refrig, (19 to 60 cu ft)	$ 500.00	$ 100.00	970	0.22				12
Solid Door Reach-in Refrig, (Greater Than 60cu ft)	$ 900.00	$ 150.00	1100	0.24				12
Solid Door Reach-in Refrig, (Less Than 19 cu ft)	$ 250.00	$ 75.00	500	0.11				12
Steamer	$ 4,100.00	$ 600.00	13,000	2.53				10
HVAC								
AC 135,000 - 240,000	$ 2,218	$ 600.00	3,367	2.83	[illegible]	2,356	3,751	15
AC 240,000 - 760,000	$ 2,876	$ 1,125.00	2,207	1.85	[illegible]	1,852	2,466	15
AC 65,000 - 135,000	$ 1,491	$ 400.00	960	0.80	727	668	1,066	15
AC greater than 760,000	$ 6,395	$ 2,925.00	8,469	7.12	[illegible]	6,956	9,422	15
AC less than 65,000 1 Ph Rooftop & Unitary	$ 278	$ 175.00	461	0.39	394	324	514	15
AC less than 65,000 3 Ph	$ 594	$ 175.00	345	0.29	285	243	384	15
Chilled Air EE Cooled Chillers	$ 9,488	$ 8,000.00	54,065	18.11	48,228	49,504	57,625	15
Chilled Water EE Cooled Chillers less than150 ton	$ 4,000	$ 1,600.00	9,148	2.56				15
Chilled Water EE Cooled Chillers 150 - 300 ton	$ 11,500	$ 9,200.00	88,246	22.73				15
Chilled Water EE Cooled Chillers greater than 300 ton	$ 50,000	$ 40,000.00	320,493	81.55				15
Chilled Water Reset Air Cooled 0-100 tons	$ 1,100	$ 250.00	388	0.00	180	160	56	5
Chilled Water Reset Air Cooled 100-200 tons	$ 1,100	$ 450.00	787	0.01	479	449	164	5
Chilled Water Reset Air Cooled 200-300 tons	$ 1,100	$ 750.00	1,328	0.01	799	749	274	5
Chilled Water Reset Air Cooled 300-400 tons	$ 1,100	$ 875.00	1,859	0.02	1,118	1,049	383	5
Chilled Water Reset Air Cooled 400-500 tons	$ 1,100	$ 900.00	2,391	0.03	1,438	1,348	492	5
Chilled Water Reset Water Cooled 0-1000 tons	$ 1,100	$ 500.00	3,066	-0.17	6,779	6,589	3,322	5
Chilled Water Reset Water Cooled 1000-2000 tons	$ 1,100	$ 750.00	9,196	-0.60	17,247	16,818	9,987	5
Chilled Water Reset Water Cooled 2000-3000 tons	$ 1,100	$ 875.00	15,326	-0.83	[illegible]	27,693	16,612	5
ES Sleeve AC under 14,000 Btu hr	$ 70	$ 25.00	67	0.01				11
ES Sleeve AC over 14,000 Btu hr	$ 100	$ 50.00	149	0.03				11
ES Window AC over 14,000 Btu hr	$ 100	$ 50.00	170	9999				11
ES Window AC under 14,000 Btu hr	$ 70	$ 25.00	78	9999				11
HP 135,000 - 240,000	$ 2,489	$ 600.00	2963	1.96	2,976	2,666	3,208	15
HP 65,000 - 135,000	$ 1,266	$ 400.00	1394	1.00	1,397	1,249	1,524	15
HP greater than 240,000	$ 3,247	$ 1,125.00	4606	3.37	4,596	4,386	5,241	15
HP less than 65,000 1 Ph	$ 366	$ 175.00	604	0.41	692	672	687	15
HP less than 65,000 3 Ph	$ 933	$ 175.00	396	0.29	409	325	423	15
Packaged Terminal AC	$ 83	$ 20.00	30	0.005	27	24	38	15
Thermal Storage Irg C&I	$ 96,250	$ 76,250.00	0	145.000				15
Custom Rebate	$ 60,000	$ 30,000.00	200,000	50				12
Other measures								
Packaged Terminal AC - Heat Pump	$ 103		43	0.005	47	42	60	
GSHP <135,000	$ 1,798		122	0.126	3,049	2,862	2,896	
WLHP <17,000	$ 22		35	0.024	38	36	43	
WLHP 17,000-65,000	$ 79		91	0.085	99	94	112	
WLHP 65,000-135,000	$ 203		227	0.161	247	234	280	
Economizer	$ 1,701		1,394	0.000	919	955	1,222	
Tuneup	$ 384		1,365	1.148	1,061	965	1,527	
High Performance Glazing	$ 5,206		7,686	5.766	489	1,119	894	
VFD Fan	$ 222		1,376	0.000	1,062	1,066	909	
Anti Sweat Heater Control	$ 30		2,618	0.002	1,995	1,844	1,519	
Efficient Refrigeration Air Cooled Condenser	$ 805		1,266	0.000	1,249	1,280	1,252	

				Indianapolis		Covington					
AC 135,000 - 240,000	Based on	20 ton	Based on 20 ton	129.08	0.14	118.38	0.13	154.43	0.14	190.37	0.14
AC 240,000 - 760,000	Based on	25 ton	Based on 25 ton	67.70	0.07	62.08	0.07	80.97	0.07	101.40	0.07
AC 65,000 - 135,000	Based on	10 ton	Based on 10 ton	72.73	0.08	66.81	0.07	87.00	0.08	108.94	0.08
AC greater than 760,000	Based on	85 ton	Based on 85 ton	99.78	0.11	91.63	0.10	119.37	0.11	149.46	0.11
AC less than 65,000 1 Ph Rooftop & Unitary	Based on	5 ton	Based on 5 ton	70.73	0.08	64.87	0.07	84.60	0.08	105.95	0.08
AC less than 65,000 3 Ph	Based on	5 ton	Based on 5 ton	52.93	0.06	48.57	0.05	63.30	0.06	79.28	0.06
Chilled Air EE Cooled Chillers	Based on	200 ton	Based on 200 ton	216.13	0.14	217.52	0.12	261.09	0.15	282.30	0.15
Chilled Water EE Cooled Chillers less than150 ton	Based on	60 ton	Based on 60 ton								
Chilled Water EE Cooled Chillers 150 - 300 ton	Based on	230 ton	Based on 230 ton								
Chilled Water EE Cooled Chillers greater than 300 ton	Based on	1000 ton	Based on 1000 ton								
Chilled Water Reset Air Cooled 0-100 tons	Based on	60 ton	Based on 60 ton	3.20	0.00	3.00	0.00	3.54	0.00	0.66	0.00
Chilled Water Reset Air Cooled 100-200 tons	Based on	150 ton	Based on 150 ton	3.20	0.00	3.00	0.00	3.54	0.00	0.66	0.00
Chilled Water Reset Air Cooled 200-300 tons	Based on	250 ton	Based on 250 ton	3.20	0.00	3.00	0.00	3.54	0.00	0.66	0.00
Chilled Water Reset Air Cooled 300-400 tons	Based on	350 ton	Based on 350 ton	3.20	0.00	3.00	0.00	3.54	0.00	0.66	0.00
Chilled Water Reset Air Cooled 400-500 tons	Based on	450 ton	Based on 450 ton	3.20	0.00	3.00	0.00	3.54	0.00	0.66	0.00
Chilled Water Reset Water Cooled 0-1000 tons	Based on	500 ton	Based on 500 ton	11.56	0.00	11.08	0.00	9.62	0.00	6.12	0.00
Chilled Water Reset Water Cooled 1000-2000 tons	Based on	1500 ton	Based on 1500 ton	11.56	0.00	11.08	0.00	9.62	0.00	6.12	0.00
Chilled Water Reset Water Cooled 2000-3000 tons	Based on	2500 ton	Based on 2500 ton	11.56	0.00	11.08	0.00	9.62	0.00	6.12	0.00
ES Sleeve AC under 14,000 Btu hr	Based on	0.75 ton	Based on 0.75 ton								
ES Sleeve AC over 14,000 Btu hr	Based on	1.70 ton	Based on 1.7 ton								
HP 135,000 - 240,000	Based on	20 ton	Based on 20 ton	148.75	0.06	144.31	0.09	155.49	0.09	161.29	0.10
HP 65,000 - 135,000	Based on	10 ton	Based on 10 ton	129.65	0.08	124.02	0.09	140.67	0.09	154.50	0.10
HP greater than 240,000	Based on	25 ton	Based on 25 ton	182.620	0.115	175.396	0.124	196.99	0.12	212.08	0.14
HP less than 65,000 1 Ph	Based on	5 ton	Based on 5 ton	118.39	0.07	114.33	0.08	125.21	0.07	132.39	0.08
HP less than 65,000 3 Ph	Based on	5 ton	Based on 5 ton	88.62	0.05	84.97	0.06	75.93	0.05	86.17	0.06
Packaged Terminal AC	Based on	0.75 ton		35.57027148	0.028465306	32.1000111	0.02849795	40.996	0.026	52.703	0.033
Packaged Terminal AC - Heat Pump	Based on	0.75 ton		52.040	0.029	55.650	0.036	63.534	0.036	67.409	0.037
GSHP <135,000	Based on	10 ton		304.294	0.161	298.243	0.162	238.164	0.125	259.786	0.140
WLHP <17,000	Based on	1 ton		38.171	0.025	36.211	0.024	40.268	0.025	43.364	0.025
WLHP 17,000-65,000	Based on	3 ton		32.921	0.022	31.242	0.021	34.950	0.023	37.815	0.022
WLHP 65,000-135,000	Based on	7.5 ton		32.921	0.022	31.242	0.021	34.950	0.023	37.816	0.022
Economizer	Based on	10 ton		91.904	0.000	95.462	0.000	134.172	0.000	120.066	0.000
Tuneup	Based on	10 ton		105.132	0.115	96.496	0.106	125.783	0.112	157.462	0.114
High Performance Glazing	Based on	100 SF		625.962	0.289	1119.151	0.631	384.302	0.186	748.725	0.298
VFD Fan	per hp	1		1435.041	0.163	1442.746	0.179	1266.548	0.062	1364.876	0.100
Anti Sweat Heater Control	per door	1		1694.633	-0.002	1644.183	0.006	1498.697	0.000	1523.065	0.000
Efficient Refrigeration Air Cooled Condenser	per ton	1		1246.352	0.148	1279.648	0.123	1329.040	0.123	1238.857	0.139

1	4	5	6	7	8	12			From database			
Covington Weather				Impacts per Measure								
Non Residential Programs/Measures	Incrementa Measure ıstomer C	Annual Customer Costs	Customer Incentive Per Unit	Annual kWh Impact	kW Impact	Measure Life	COP	kW/Ton	Incrementa Measure Cost per unit	Typical size	kWh/unit	kW/unit
Air-Cooled Recip Chiller COP = 2.86, IPLV = 3.12	$9,014			6,331	4.6	20	1.23	1.13	$45.07	200	32	0.023
Air-Cooled Recip Chiller COP = 2.86, IPLV = 3.48	$11,482			30,510	8.4	20	1.23	1.01	$57.41	200	153	0.042
Air-Cooled Recip Chiller COP = 2.86, IPLV = 3.97	$20,645			55,786	12.7	20	1.23	0.89	$103.22	200	279	0.063
Air-Cooled Recip Chiller COP = 2.86, IPLV = 4.33	$26,052			67,681	14.0	20	1.23	0.81	$130.26	200	338	0.070
Air-Cooled Screw Chiller COP = 2.86, IPLV = 3.12	$10,114			6,350	4.7	20	1.23	1.13	$50.57	200	32	0.023
Air-Cooled Screw Chiller COP = 2.86, IPLV = 3.48	$12,547			32,447	9.0	20	1.23	1.01	$62.73	200	162	0.045
Air-Cooled Screw Chiller COP = 2.86, IPLV = 3.97	$16,190			42,631	12.6	20	1.23	0.89	$80.95	200	213	0.063
Air-Cooled Screw Chiller COP = 2.86, IPLV = 4.33	$32,512			77,196	16.5	20	1.23	0.81	$162.56	200	386	0.082

Documentation / Sources

Please provide the sources and a brief description as to where the assumptions for the following inputs were derived

Input/Assumption	Describe Source (Provide link if possible)
Costs	
Implemenation Costs	
Admin Costs	Morgan Marketing Partners
Customer Cost	Architectural Energy Corp/Building Metrics
Customer Incentive	Morgan Marketing Partners
Annual Fixed costs	
Impact Savings	
kWh	Architectural Energy Corp/Building Metrics
Peak (kW) Coincident	Architectural Energy Corp/Building Metrics
Target (kW) Non-Coincident	Architectural Energy Corp/Building Metrics
Free Ridership Percentage	Morgan Marketing Partners
Measure Life	Architectural Energy Corp/Building Metrics
LoadShape	Morgan Marketing Partners
Target Months	Morgan Marketing Partners
Days Use	Morgan Marketing Partners
Start Hour	Morgan Marketing Partners
Weather Sensitivity (Mode)	Morgan Marketing Partners

Any other sources or references not mentioned above:

AEC Savings Modeling Spreadsheet

Global

Enter weights into turquoise cells. Weights need not sum to 1.0.

Climate	Weight	Normalized
IN_Indianapolis_Intl_AP	0.000	[redacted]
KY_Cincinnati_Northern_Ky	1.000	
NC_Asheville_Regional_Ap	0.000	
NC_Charlotte_Douglas_Intl	0.000	
SC_Greenville_Downtown_Ap	0.000	
	1.000	

Commercial

Building Type	Weight	Normalized
Assembly	1.000	[redacted]
Big Box Retail	1.000	
Fast Food Restaurant	1.000	
Full Service Restaurant	1.000	
Grocery	1.000	
Hospital	1.000	
Hotel	1.000	
Large Office	1.000	
Light Industrial	1.000	
Primary School	1.000	
Small Office	1.000	
Small Retail	1.000	
Warehouse	1.000	
Sum	13.000	

Large Office, Hospital, Hotel HVAC	Weight	Normalized
CV reheat econ with Air Cooled Chiller	1.00	[redacted]
CV reheat econ with Gas Engine Chiller	1.00	
CV reheat econ with Water Cooled Chiller	1.00	
CV reheat no econ with Air Cooled Chiller	1.00	
CV reheat no econ with Gas Engine Chiller	1.00	
CV reheat no econ with Water Cooled Chiller	1.00	
VAV reheat econ with Air Cooled Chiller	1.00	
VAV reheat econ with Gas Engine Chiller	1.00	
VAV reheat econ with Water Cooled Chiller	1.00	
Sum	9.00	

Single Family Residential

Vintage	Weight	Normalized
Old	[redacted]	[redacted]
Average		
New		
Sum	2.00	

System	Weight	Normalized
Central AC with elec furnace	[redacted]	[redacted]
Central AC with gas furnace		
Central air source heat pump		
Central dual fuel heat pump		
Elec furnace no AC		
Gas furnace no AC		
Sum	6.00	

Building type	Weight	Normalized
Basement	0.700	[redacted]
Crawl	0.300	
Sum	1.000	

Measure	kWh/unit	Summer kW/unit	Winter kW/unit	Unit
AC <65,000 1 Ph	57	0.072	0.001	0.0 ton
AC <65,000 3 Ph	43	0.054	0.001	0.0 ton
AC >760,000	50	0.162	0.002	0.0 ton
AC 135,000 - 240,000	104	0.131	0.002	0.0 ton
AC 240,000 - 760,000	34	0.060	0.001	0.0 ton
AC 65,000 - 135,000	86	0.075	0.002	0.0 ton
Air-Cooled Recip Chiller COP = 2.8, IPLV = 3.41	113	[illegible]	0.007	0.0 ton
Air-Cooled Recip Chiller COP = 2.8, IPLV = 3.80	[illegible]	0.042	0.013	0.0 ton
Air-Cooled Recip Chiller COP = 2.8, IPLV = 4.34	[illegible]	0.052	0.017	0.0 ton
Air-Cooled Recip Chiller COP = 3.05, IPLV = 3.74	[illegible]	0.101	0.024	0.0 ton
Air-Cooled Recip Chiller COP = 3.05, IPLV = 3.78	[illegible]	0.119	0.031	0.0 ton
Air-Cooled Recip Chiller COP = 3.05, IPLV = 4.28	[illegible]	0.130	[illegible]	0.0 ton
Air-Cooled Recip Chiller COP = 3.05, IPLV = 4.67	[illegible]	0.149	0.040	0.0 ton
Air-Cooled Recip Chiller COP = 3.36, IPLV = [illegible]	[illegible]	0.166	[illegible]	0.0 ton
Air-Cooled Recip Chiller COP = 3.36, IPLV = 4.10	445	0.203	0.051	0.0 ton
Air-Cooled Recip Chiller COP = 3.36, IPLV = 4.57	551	0.221	0.059	0.0 ton
Air-Cooled Recip Chiller COP = 3.36, IPLV = 5.09	603	0.239	0.068	0.0 ton
Air-Cooled Screw Chiller COP = 2.8, IPLV = 3.40	199	[illegible]	0.008	0.0 ton
Air-Cooled Screw Chiller COP = 2.8, IPLV = 3.94	178	[illegible]	0.009	0.0 ton
Air-Cooled Screw Chiller COP = 2.8, IPLV = 4.75	342	[illegible]	0.021	0.0 ton
Air-Cooled Screw Chiller COP = 3.06, IPLV = [illegible]	191	0.101	0.024	0.0 ton
Air-Cooled Screw Chiller COP = 3.06, IPLV = 3.80	307	0.121	0.031	0.0 ton
Air-Cooled Screw Chiller COP = 3.06, IPLV = 4.60	361	0.137	0.039	0.0 ton
Air-Cooled Screw Chiller COP = 3.06, IPLV = 5.22	503	0.165	0.043	0.0 ton
Air-Cooled Screw Chiller COP = 3.36, IPLV = 3.45	382	0.187	0.044	0.0 ton
Air-Cooled Screw Chiller COP = 3.36, IPLV = 4.15	450	0.205	0.051	0.0 ton
Air-Cooled Screw Chiller COP = 3.36, IPLV = 4.42	[illegible]	0.220	[illegible]	0.0 ton
Air-Cooled Screw Chiller COP = 3.36, IPLV = [illegible]	[illegible]	0.236	0.082	0.0 ton
Aux Small Heater Control	1,074	[illegible]	[illegible]	-12.4 door
CHW reset 10 deg	107	[illegible]	0.008	1.1 ton
CHW reset 5 deg	57	[illegible]	0.008	0.8 ton
Cool roof	261	[illegible]	0.004	-16.7 1000 sq ft roof
DCV	367	[illegible]	0.038	346.4 1000 sq ft cera
Economizer	121	[illegible]	0.028	-2.3 ton
Efficient Condenser	1,447	[illegible]	0.009	0.0 ton
EMS	[illegible]	[illegible]	-0.001	24.2 1000 sq ft cera
Engineered CKV hood	671	[illegible]	0.469	146.4 100 cfm hd
Floating Head Pressure Control	1,580	[illegible]	0.009	0.0 ton
GSHP <135,000 17EER	222	0.115	0.065	0.0 ton
GSHP <135,000 19EER	503	0.159	0.112	0.0 ton
GSHP <135,000 EER 17 ASHP base	1,019	0.325	2.032	0.0 ton
GSHP <135,000 EER 19 ASHP base	1,[illegible]	0.370	[illegible]	0.0 ton
High Performance Glazing	[illegible]	0.146	0.025	1.3 100 sq ft glazing
HP <65,000 1 Ph	111	[illegible]	[illegible]	0.0 ton
HP <65,000 3 Ph	61	0.054	[illegible]	0.0 ton
HP >240,000	[illegible]	0.126	[illegible]	0.0 ton
HP 135,000 - 240,000	141	[illegible]	[illegible]	0.0 ton
HP 65,000 - 135,000	119	[illegible]	[illegible]	0.0 ton
Night Covers	76	[illegible]	[illegible]	8.6 LF of case
PTAC	79	[illegible]	[illegible]	0.0 ton
PTAC-HP	81	[illegible]	[illegible]	0.0 ton
Refrigerant charging correction	[illegible]	0.107	[illegible]	0.0 ton
Roof Insulation	261	-0.006	[illegible]	74.8 1000 sq ft roof
Setback/Setup	1,[illegible]	[illegible]	0.039	343.2 1000 sq ft cera
VFD Fan	1,243	0.196	0.143	-94.1 per fan hp
VFD Pump	3,549	[illegible]	[illegible]	0.0 per CHW pump
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0.29 kW	373	0.124	0.043	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0.33 kW	343	0.119	0.041	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0.35 kW	312	0.117	0.040	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0.37 kW	[illegible]	0.114	0.039	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0.44 kW	[illegible]	0.106	0.034	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0.31 kW	274	0.072	[illegible]	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0.37 kW	[illegible]	0.067	[illegible]	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0.38 kW	[illegible]	[illegible]	[illegible]	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0.42 kW	[illegible]	0.062	0.022	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0.49 kW	119	0.054	0.017	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0.35 kW	175	[illegible]	[illegible]	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0.41 kW	125	0.014	[illegible]	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0.44 kW	[illegible]	0.011	[illegible]	0.0 ton
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0.47 kW	75	0.009	[illegible]	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton with 0.3	[illegible]	0.135	0.047	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton with 0.3	340	[illegible]	0.046	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton with 0.3	337	[illegible]	0.043	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton with 0.4	317	0.126	0.042	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton with 0.4	256	0.118	0.037	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton with 0.3	[illegible]	0.079	[illegible]	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton with 0.4	[illegible]	0.073	0.027	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton with 0.4	[illegible]	0.070	[illegible]	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton with 0.4	167	0.051	[illegible]	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton with 0.5	127	[illegible]	[illegible]	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton with 0.3	167	0.022	0.012	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton with 0.4	132	0.015	[illegible]	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton with 0.4	103	0.012	[illegible]	0.0 ton
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton with 0.5	77	0.009	[illegible]	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton with 0	[illegible]	0.151	[illegible]	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton with 0	409	0.146	0.050	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton with 0	380	0.142	0.048	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton with 0	357	0.140	0.047	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton with 0	294	0.131	0.042	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton with 0	334	[illegible]	0.036	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton with 0	279	0.081	0.030	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton with 0	256	0.078	0.029	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton with 0	224	0.076	0.027	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton with 0	142	0.055	0.021	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton with 0	214	0.025	0.014	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton with 0	152	0.017	0.011	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton with 0	129	0.014	[illegible]	0.0 ton
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton with 0	82	0.011	0.007	0.0 ton
Water-cooled screw chiller < 150 ton 0.63 kW/ton with 0.38 kW	487	0.182	[illegible]	0.0 ton
Water-cooled screw chiller < 150 ton 0.63 kW/ton with 0.41 kW	435	0.178	0.048	0.0 ton
Water-cooled screw chiller < 150 ton 0.63 kW/ton with 0.44 kW	405	0.172	0.044	0.0 ton
Water-cooled screw chiller < 150 ton 0.63 kW/ton with 0.47 kW	372	0.166	0.042	0.0 ton
Water-cooled screw chiller < 150 ton 0.63 kW/ton with 0.5 kW	345	0.162	0.041	0.0 ton
Water-cooled screw chiller < 150 ton 0.63 kW/ton with 0.56 kW	[illegible]	0.151	0.037	0.0 ton
Water-cooled screw chiller < 150 ton 0.71 kW/ton with 0.43 kW	345	0.111	[illegible]	0.0 ton
Water-cooled screw chiller < 150 ton 0.71 kW/ton with 0.48 kW	315	0.105	[illegible]	0.0 ton
Water-cooled screw chiller < 150 ton 0.71 kW/ton with 0.5 kW	278	[illegible]	0.027	0.0 ton
Water-cooled screw chiller < 150 ton 0.71 kW/ton with 0.56 kW	240	0.092	0.024	0.0 ton

Measure	kWh/unit	Summer kW/unit	Winter kW/unit	Units
Attic Can Lights	34	0.003	0.011	9.4 Light
ASHP - SEER 14	135	0.163	0.007	0.8 ton
ASHP - SEER 15	238	0.263	0.096	4.8 ton
ASHP - SEER 16	374	0.329	0.216	4.4 ton
ASHP - SEER 17	438	0.333	0.213	6.6 ton
ASHP - SEER 18	467	0.344	0.229	6.6 ton
Basement Wall Insulation	655	-0.034	0.287	35.0 1000 sq ft basement wall area
Ceiling Fans	53	0.033	0.009	0.6 fan
Cool roof	-8	0.019	-0.001	-1.1 1000 sq ft roof area
DFHP - SEER 14	164	0.163	0.005	-1.5 ton
DFHP - SEER 14 with 95 AFUE furnace	164	0.163	0.085	5.5 ton
DFHP - SEER 15	367	0.263	0.146	-8.1 ton
DFHP - SEER 15 with 95 AFUE furnace	367	0.263	0.146	1.9 ton
DFHP - SEER 16	424	0.239	0.169	-2.6 ton
DFHP - SEER 16 with 95 AFUE furnace	424	0.329	0.169	4.7 ton
DFHP - SEER 17	511	0.333	0.179	-3.5 ton
DFHP - SEER 17 with 95 AFUE furnace	511	0.333	0.179	3.7 ton
DFHP - SEER 18	529	0.345	0.161	-3.2 ton
DFHP - SEER 18 with 95 AFUE furnace	529	0.345	0.161	4.3 ton
Door weatherstripping	23	0.001	0.011	9.8 Door
Duct insulation	361	0.038	0.371	16.6 1000 sq ft cond floor area
Duct insulation	788	0.128	0.964	36.1 1000 sq ft cond floor area
Duct sealing 15% leakage base	181	0.031	0.223	6.9 1000 sq ft cond floor area
Duct sealing 20% leakage base	264	0.044	0.330	8.8 1000 sq ft cond floor area
Duct sealing 30% leakage base	360	0.058	0.446	13.0 1000 sq ft cond floor area
Duct sealing 35% leakage base	495	0.071	0.644	16.7 1000 sq ft cond floor area
Energy Star Door	149	0.019	0.050	4.7 Door
Floor Insulation	348	-0.136	0.463	16.2 1000 sq ft floor area
Furnace/AC - SEER 14	100	0.166	0.022	-1.3 ton
Furnace/AC - SEER 14 with 95 AFUE furnace	136	0.166	0.839	43.2 ton
Furnace/AC - SEER 15	88	0.171	0.018	-2.2 ton
Furnace/AC - SEER 15 with 95 AFUE furnace	147	0.171	0.834	41.6 ton
Furnace/AC - SEER 16	66	0.174	0.182	-2.6 ton
Furnace/AC - SEER 16 with 95 AFUE furnace	127	0.174	0.815	40.6 ton
Furnace/AC - SEER 17	111	0.207	0.143	-3.3 ton
Furnace/AC - SEER 17 with 95 AFUE furnace	169	0.207	0.026	38.6 ton
GSHP - EER 17	379	0.142	0.139	0.0 ton
GSHP - EER 19	467	0.169	0.160	0.0 ton
GSHP - EER 17 ASHP Base	1,651	0.348	2.223	0.0 ton
GSHP - EER 19 ASHP Base	1,759	0.403	2.282	0.0 ton
Infiltration reduction - 10%	161	0.019	0.072	5.3 1000 sq ft cond floor area
Infiltration reduction - 10% and attic insulation	336	0.039	0.189	11.5 1000 sq ft cond floor area
Infiltration reduction - 20%	302	0.039	0.149	10.5 1000 sq ft cond floor area
Infiltration reduction - 20% and attic insulation	466	0.057	0.280	16.7 1000 sq ft cond floor area
Infiltration reduction - 30%	454	0.053	0.226	15.8 1000 sq ft cond floor area
Infiltration reduction - 30% and attic insulation	609	0.072	0.349	22.0 1000 sq ft cond floor area
Infiltration reduction - 50%	752	0.090	0.387	26.3 1000 sq ft cond floor area
Infiltration reduction - 50% and attic insulation	949	0.109	0.527	32.4 1000 sq ft cond floor area
RCA 10% improvement	39	0.074	0.000	0.0 ton
RCA 15% improvement	58	0.113	0.000	0.0 ton
RCA 5% improvement	19	0.037	0.000	0.0 ton
Roof Insulation	378	0.025	0.170	9.4 1000 sq ft roof area
Setback thermostat - fall setback	757	-0.006	-1.416	23.2 1000 sq ft cond floor area
Setback thermostat - moderate setback	448	-0.005	-0.800	13.4 1000 sq ft cond floor area
Wall Insulation	449	0.040	0.223	15.3 1000 sq ft wall area
Whole House Fan	58	0.000	0.000	0.0 1000 sq ft cond floor area
Window Film	-204	0.095	-0.024	-13.3 100 sq ft window area
Window Replacement	448	0.116	0.308	13.7 100 sq ft window area

Water-cooled screw chiller < 150 ton 0.71 kW/ton with 0.58 kW	212	0.087	0.020	0.0 ton	20	$443.30	$531.11	$87.72	$76.00	$607.11	60
Water-cooled screw chiller < 150 ton 0.71 kW/ton with 0.53 kW	145	0.070	0.019	0.0 ton	20	$443.30	$499.62	$55.63	$76.00	$575.62	60
Water-cooled screw chiller < 150 ton 0.78 kW/ton with 0.47 kW	225	0.030	0.013	0.0 ton	20	$443.30	$546.81	$103.43	$76.00	$622.81	65
Water-cooled screw chiller < 150 ton 0.78 kW/ton with 0.51 kW	192	0.033	0.011	0.0 ton	20	$443.30	$508.80	$65.50	$76.00	$584.80	65
Water-cooled screw chiller < 150 ton 0.78 kW/ton with 0.55 kW	161	0.026	0.009	0.0 ton	20	$443.30	$511.15	$67.74	$76.00	$587.15	60
Water-cooled screw chiller < 150 ton 0.78 kW/ton with 0.60 kW	100	0.016	0.006	0.0 ton	20	$443.30	$493.17	$49.87	$76.00	$569.17	57
Water-cooled screw chiller < 150 ton 0.78 kW/ton with 0.62 kW	77	0.013	0.004	0.0 ton	20	$443.30	$479.05	$35.68	$76.00	$555.05	60
Water-cooled screw chiller > 300 ton 0.51 kW/ton with 0.31 kW	374	0.148	0.039	0.0 ton	20	$275.84	$389.89	$114.05	$37.00	$426.89	1000
Water-cooled screw chiller > 300 ton 0.51 kW/ton with 0.33 kW	363	0.144	0.036	0.0 ton	20	$275.84	$379.86	$104.02	$37.00	$416.86	1000
Water-cooled screw chiller > 300 ton 0.51 kW/ton with 0.35 kW	309	0.140	0.036	0.0 ton	20	$275.84	$369.83	$93.99	$37.00	$406.83	1000
Water-cooled screw chiller > 300 ton 0.51 kW/ton with 0.38 kW	302	0.135	0.034	0.0 ton	20	$275.84	$359.80	$83.96	$37.00	$396.80	1000
Water-cooled screw chiller > 300 ton 0.51 kW/ton with 0.4 kW	263	0.151	0.030	0.0 ton	20	$275.84	$351.77	$75.93	$37.00	$388.77	1000
Water-cooled screw chiller > 300 ton 0.51 kW/ton with 0.46 kW	232	0.128	0.030	0.0 ton	20	$275.84	$331.71	$55.87	$37.00	$368.71	1000
Water-cooled screw chiller > 300 ton 0.58 kW/ton with 0.35 kW	278	0.090	0.027	0.0 ton	20	$275.84	$369.22	$93.38	$37.00	$406.22	1000
Water-cooled screw chiller > 300 ton 0.58 kW/ton with 0.37 kW	252	0.089	0.023	0.0 ton	20	$275.84	$357.64	$82.16	$37.00	$394.64	1000
Water-cooled screw chiller > 300 ton 0.58 kW/ton with 0.4 kW	224	0.080	0.022	0.0 ton	20	$275.84	$346.56	$70.72	$37.00	$383.56	1000
Water-cooled screw chiller > 300 ton 0.58 kW/ton with 0.43 kW	194	0.075	0.020	0.0 ton	20	$275.84	$335.37	$59.53	$37.00	$372.37	1000
Water-cooled screw chiller > 300 ton 0.58 kW/ton with 0.45 kW	173	0.071	0.019	0.0 ton	20	$275.84	$326.34	$50.51	$37.00	$363.34	1000
Water-cooled screw chiller > 300 ton 0.58 kW/ton with 0.51 kW	116	0.061	0.015	0.0 ton	20	$275.84	$303.77	$27.94	$37.00	$340.77	1000
Water-cooled screw chiller > 300 ton 0.64 kW/ton with 0.36 kW	176	0.052	0.011	0.0 ton	20	$275.84	$348.56	$72.72	$37.00	$385.56	1000
Water-cooled screw chiller > 300 ton 0.64 kW/ton with 0.42 kW	152	0.027	0.009	0.0 ton	20	$275.84	$336.02	$60.18	$37.00	$373.02	1000
Water-cooled screw chiller > 300 ton 0.64 kW/ton with 0.45 kW	121	0.021	0.007	0.0 ton	20	$275.84	$322.89	$47.05	$37.00	$359.89	1000
Water-cooled screw chiller > 300 ton 0.64 kW/ton with 0.48 kW	87	0.016	0.005	0.0 ton	20	$275.84	$310.95	$35.11	$37.00	$347.95	1000
Water-cooled screw chiller > 300 ton 0.64 kW/ton with 0.51 kW	63	0.011	0.004	0.0 ton	20	$275.84	$300.81	$25.00	$37.00	$337.81	1000
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton with 0.5	419	0.188	0.044	0.0 ton	20	$346.94	$496.35	$149.41	$53.00	$549.35	230
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton with 0.3	366	0.162	0.042	0.0 ton	20	$346.94	$484.30	$137.36	$53.00	$537.30	230
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton with 0.4	367	0.157	0.041	0.0 ton	20	$346.94	$472.25	$125.31	$53.00	$525.25	230
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton with 0.4	337	0.151	0.039	0.0 ton	20	$346.94	$460.20	$113.26	$53.00	$513.20	230
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton with 0.4	316	0.147	0.037	0.0 ton	20	$346.94	$450.56	$103.62	$53.00	$503.56	230
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton with 0.5	288	0.138	0.034	0.0 ton	20	$346.94	$425.46	$78.52	$53.00	$478.46	230
Water-cooled screw chiller 150 - 300 ton 0.66 kW/ton with 0.3	306	0.101	0.030	0.0 ton	20	$346.94	$465.30	$118.36	$53.00	$518.30	230
Water-cooled screw chiller 150 - 300 ton 0.66 kW/ton with 0.4	282	0.095	0.026	0.0 ton	20	$346.94	$451.77	$104.83	$53.00	$504.77	230
Water-cooled screw chiller 150 - 300 ton 0.66 kW/ton with 0.4	251	0.090	0.024	0.0 ton	20	$346.94	$438.21	$91.27	$53.00	$491.21	230
Water-cooled screw chiller 150 - 300 ton 0.66 kW/ton with 0.4	217	0.084	0.022	0.0 ton	20	$346.94	$424.66	$77.72	$53.00	$477.66	230
Water-cooled screw chiller 150 - 300 ton 0.66 kW/ton with 0.5	192	0.080	0.021	0.0 ton	20	$346.94	$413.61	$66.67	$53.00	$466.61	230
Water-cooled screw chiller 150 - 300 ton 0.66 kW/ton with 0.5	130	0.069	0.017	0.0 ton	20	$346.94	$382.70	$35.76	$53.00	$435.70	230
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton with 0.4	263	0.035	0.012	0.0 ton	20	$346.94	$434.30	$87.36	$53.00	$487.30	230
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton with 0.4	172	0.030	0.010	0.0 ton	20	$346.94	$419.24	$72.30	$53.00	$472.24	230
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton with 0.5	130	0.024	0.008	0.0 ton	20	$346.94	$404.18	$57.24	$53.00	$457.18	230
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton with 0.5	97	0.017	0.006	0.0 ton	20	$346.94	$389.11	$42.17	$53.00	$442.11	230
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton with 0.6	66	0.012	0.004	0.0 ton	20	$346.94	$377.06	$30.12	$53.00	$430.06	230
Window Film	409	0.170	0.023	-46.8 100 sqft glazin	10	$0.00	[illegible]	$80.00	$53.52	$183.01	0
WLHP <17,000	35	0.022	0.011	-0.3 ton	15	$581.14	$580.14	$35.00	$229.97	$815.11	1
WLHP 17,000-65,000	30	0.030	0.009	-0.2 ton	15	$581.14	$587.40	$36.29	$229.97	$817.40	3
WLHP 65,000-135,000	30	0.020	0.008	-0.2 ton	15	$581.14	$588.20	$37.06	$229.97	$818.17	7.5

Multi Family Residential

Vintage	Weight	Normalized
Old	[redacted]	
Average		
New		
Sum	3.00	

System	Weight	Normalized
Central AC with elec furnace	[redacted]	
Central AC with gas furnace		
Central air source heat pump		
Central dual fuel heat pump		
Elec furnace no AC		
Gas furnace no AC		
PTAC		
PTHP		
Sum	3.70	

Building Type	Weight	Normalized
MF 2-4	[redacted]	
MF 5+		
Sum	2.00	

Measure	MWh/unit	Summer MW/unit	Winter MW/unit	Therms/unit	Units	EUL	Base Equipment Cost per Unit	Measure Equipment Cost per Unit	Incremental Equipment Cost per Unit	Labor Cost per Unit	Installed Cost per Unit	Typical size
Airtight Can Lights	0	0.000	0.000	0.0	Light	15	$38.50	$94.69	$56.07	$12.15	$78.65	4
ASHP - SEER 14	0	0.000	0.000	0.0	ton	15	$630.84	$728.78	$97.94	$235.85	$864.73	3
ASHP - SEER 15	0	0.000	0.000	0.0	ton	15	$630.84	$826.72	$195.87	$235.85	$1,062.57	3
ASHP - SEER 16	0	0.000	0.000	0.0	ton	15	$630.84	$924.65	$293.81	$235.85	$1,160.50	3
ASHP - SEER 17	0	0.000	0.000	0.0	ton	15	$630.84	$1,022.58	$391.74	$235.85	$1,258.54	3
ASHP - SEER 18	0	0.000	0.000	0.0	ton	15	$630.84	$1,120.62	$489.68	$235.85	$1,356.47	3
Cool roof	0	0.000	0.000	0.0	1000 sq ft roof area	20	$310.00	$410.00	$100.00	$355.00	$765.00	3.25
DFHP - SEER 14	0	0.000	0.000	0.0	ton	15	$549.55	$642.17	$92.62	$235.85	$878.12	3
DFHP - SEER 14 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,389.59	$586.04	$799.57	$2,188.74	3
DFHP - SEER 15	0	0.000	0.000	0.0	ton	15	$549.55	$734.78	$185.24	$235.85	$970.74	3
DFHP - SEER 15 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,462.12	$679.57	$799.57	$2,246.36	3
DFHP - SEER 16	0	0.000	0.000	0.0	ton	15	$549.55	$827.41	$277.86	$235.85	$1,063.26	3
DFHP - SEER 16 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,554.74	$772.19	$799.57	$2,340.98	3
DFHP - SEER 17	0	0.000	0.000	0.0	ton	15	$549.55	$920.03	$370.47	$235.85	$1,155.88	3
DFHP - SEER 17 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,647.36	$864.81	$799.57	$2,433.60	3
DFHP - SEER 18	0	0.000	0.000	0.0	ton	15	$549.55	$1,038.55	$489.00	$235.85	$1,274.40	3
DFHP - SEER 18 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,765.88	$983.33	$799.57	$2,552.12	3
Door weatherstripping	0	0.000	0.000	0.0	Door	5	$0.00	$13.00	$12.00	$30.00	$43.00	1
Duct insulation	0	0.000	0.000	0.0	1000 sq ft cond. floor area	20	$0.00	$100.00	$100.00	$140.00	$240.00	3
Duct location	0	0.000	0.000	0.0	1000 sq ft cond. floor area	30	$0.00	$750.00	$750.00	$0.00	$750.00	3
Duct sealing 15% leakage base	0	0.000	0.000	0.0	1000 sq ft cond. floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
Duct sealing 20% leakage base	0	0.000	0.000	0.0	1000 sq ft cond. floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
Duct sealing 25% leakage base	0	0.000	0.000	0.0	1000 sq ft cond. floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
Duct sealing 30% leakage base	0	0.000	0.000	0.0	1000 sq ft cond. floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
ECM blower - continuous	0	0.000	0.000	0.0	ton	15	$0.00	$176.00	$176.00	$159.85	$335.85	3
ECM blower - intermittent	0	0.000	0.000	0.0	ton	15	$0.00	$176.00	$176.00	$159.85	$335.85	3
Energy Star Door	0	0.000	0.000	0.0	Door	20	$285.00	$1,400.00	$1,115.00	$1,500.00	$2,900.00	1
Furnace/AC - SEER 14	0	0.000	0.000	0.0	ton	15	$549.55	$642.17	$92.62	$235.85	$878.12	3
Furnace/AC - SEER 14 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,389.59	$586.05	$799.57	$2,188.74	3
Furnace/AC - SEER 15	0	0.000	0.000	0.0	ton	15	$549.55	$734.78	$185.24	$235.85	$970.74	3
Furnace/AC - SEER 15 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,462.12	$679.57	$799.57	$2,246.36	3
Furnace/AC - SEER 16	0	0.000	0.000	0.0	ton	15	$549.55	$827.41	$277.86	$235.85	$1,063.26	3
Furnace/AC - SEER 16 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,554.74	$772.19	$799.57	$2,340.98	3
Furnace/AC - SEER 17	0	0.000	0.000	0.0	ton	15	$549.55	$920.03	$370.47	$235.85	$1,155.88	3
Furnace/AC - SEER 17 with 95 AFUE furnace	0	0.000	0.000	0.0	ton	15	$782.55	$1,647.36	$864.81	$799.57	$2,433.60	3
High efficiency furnace with ECM	0	0.000	0.000	0.0	kBtu/hr capacity	15	$6.50	$21.00	$14.50	$15.52	$36.52	100
High efficiency furnace without ECM	0	0.000	0.000	0.0	kBtu/hr capacity	15	$6.50	$15.67	$9.56	$11.00	$26.55	100
Infiltration reduction - 30%	0	0.000	0.000	0.0	1000 sq ft cond floor area	13	$0.00	$20.00	$20.00	$100.00	$120.00	3
Infiltration reduction - 30% and attic insulation	0	0.000	0.000	0.0	1000 sq ft cond floor area	13	$0.00	$584.82	$584.82	$292.13	$876.95	3
Infiltration reduction - 50%	0	0.000	0.000	0.0	1000 sq ft cond floor area	13	$0.00	$20.00	$20.00	$100.00	$120.00	3
Infiltration reduction - 50% and attic insulation	0	0.000	0.000	0.0	1000 sq ft cond floor area	13	$0.00	$584.82	$584.82	$292.13	$876.95	3
O&M Tune-up	0	0.000	0.000	0.0	ton	10	$0.00	$17.87	$17.87	$28.47	$46.33	3
PTAC 10.3 EER	0	0.000	0.000	0.0	ton	15	$741.91	$907.63	$165.72	$132.50	$1,040.00	0.75
PTAC 9.5 EER	0	0.000	0.000	0.0	ton	15	$889.25	$990.04	$100.79	$137.80	$1,127.84	0.75
PTHP 10.5 EER	0	0.000	0.000	0.0	ton	15	$925.75	$1,132.57	$206.82	$402.60	$1,535.17	0.75
PTHP 9.1 EER	0	0.000	0.000	0.0	ton	15	$1,003.01	$1,229.53	$226.52	$322.00	$1,557.81	0.75
RCA 10% improvement	0	0.000	0.000	0.0	ton	10	$0.00	$17.87	$17.87	$28.47	$46.33	3
RCA 15% improvement	0	0.000	0.000	0.0	ton	10	$0.00	$27.03	$27.03	$119.24	$146.27	3
Roof insulation	0	0.000	0.000	0.0	1000 sq ft roof area	25	$0.00	$584.82	$584.82	$182.13	$766.95	3
Setback thermostat - full setback	0	0.000	0.000	0.0	1000 sq ft cond floor area	9	$14.91	$25.65	$10.74	$7.72	$33.38	3
Setback thermostat - moderate setback	0	0.000	0.000	0.0	1000 sq ft cond floor area	9	$14.91	$25.65	$10.74	$7.72	$33.38	3
Wall insulation	0	0.000	0.000	0.0	1000 sq ft wall area	20	$0.00	$151.98	$151.98	$1,170.84	$1,322.82	2.3
Window Film	0	0.000	0.000	0.0	100 sq ft window area	10	$0.00	$88.00	$88.00	$63.82	$153.81	3.5
Window Replacement	0	0.000	0.000	0.0	100 sq ft window area	20	$1,649.97	$2,068.60	$428.63	$206.97	$2,275.57	3.5

Manufactured Homes

Vintage	Weight	Normalized
76-84	[redacted]	
85-95		
Pre76		
Sum	3.000	

System	Weight	Normalized
Central AC with elec furnace	[redacted]	
Central AC with gas furnace		
Central air source heat pump		
Central dual fuel heat pump		
Elec furnace no AC		
Gas furnace no AC		
Sum	6	

Measure	MWh/unit	Summer kW/unit	Winter kW/unit	Therms/unit	Units	EUL	Base Equipment Cost per Unit	Measure Equipment Cost per Unit	Incremental Equipment Cost per Unit	Labor Cost per Unit	Installed Cost per Unit	Typical size
ASHP - SEER 14	98	0.078	0.000	0.0	ton	15	$630.84	$728.78	$97.94	$235.85	$964.73	3
ASHP - SEER 15	209	0.164	-0.018	0.0	ton	15	$630.84	$826.72	$195.87	$235.85	$1,062.57	3
ASHP - SEER 16	362	0.136	-0.040	0.0	ton	15	$630.84	$924.65	$293.81	$235.85	$1,160.50	3
ASHP - SEER 17	430	0.140	-0.061	0.0	ton	15	$630.84	$1,022.58	$391.74	$235.85	$1,258.54	3
ASHP - SEER 18	462	0.168	-0.061	0.0	ton	15	$630.84	$1,120.62	$489.68	$235.85	$1,356.47	3
Ceiling Fans	81	0.054	0.000	0.0	fan	15	$0.00	$25.00	$25.00	$350.00	$375.00	4
Crawlspace Wall Insulation	307	0.040	0.149	7.9	1000 sq ft crawl wall area	30	$0.00	$273.35	$273.35	$416.79	$690.13	4.8
DFHP - SEER 14	114	0.078	0.000	-0.8	ton	15	$549.55	$642.17	$92.62	$235.85	$878.12	3
DFHP - SEER 15	276	0.164	0.143	-4.4	ton	15	$549.55	$734.78	$185.24	$235.85	$970.74	3
DFHP - SEER 16	382	0.136	0.000	-1.3	ton	15	$549.55	$827.41	$277.86	$235.85	$1,063.26	3
DFHP - SEER 17	460	0.140	0.172	-1.8	ton	15	$549.55	$920.03	$370.47	$235.85	$1,155.88	3
DFHP - SEER 18	488	0.168	0.182	-1.6	ton	15	$549.55	$1,038.55	$489.00	$235.85	$1,274.40	3
DFHP - SEER 14 with 95 AFUE furnace	114	0.076	0.000	2.0	ton	15	$782.55	$1,389.59	$586.05	$799.57	$2,188.74	3
DFHP - SEER 15 with 95 AFUE furnace	276	0.164	0.143	6.1	ton	15	$782.55	$1,462.12	$679.57	$799.57	$2,246.36	3
DFHP - SEER 16 with 95 AFUE furnace	382	0.136	0.000	3.0	ton	15	$782.55	$1,554.74	$772.19	$799.57	$2,340.98	3
DFHP - SEER 17 with 95 AFUE furnace	460	0.140	0.172	2.2	ton	15	$782.55	$1,647.36	$864.81	$799.57	$2,433.60	3
DFHP - SEER 18 with 95 AFUE furnace	488	0.168	0.182	2.4	ton	15	$782.55	$1,765.88	$983.33	$799.57	$2,552.12	3
Duct insulation	868	0.100	0.487	17.2	1000 sq ft cond floor area	20	$0.00	$100.00	$100.00	$140.00	$240.00	3
Duct sealing 15% leakage base	318	0.035	0.262	12.6	1000 sq ft cond floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
Duct sealing 20% leakage base	490	0.067	0.400	20.0	1000 sq ft cond floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
Duct sealing 25% leakage base	664	0.085	0.543	27.2	1000 sq ft cond floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
Duct sealing 30% leakage base	838	0.104	0.687	34.7	1000 sq ft cond floor area	18	$0.00	$33.33	$33.33	$182.49	$215.82	3
Floor Insulation	441	0.039	0.232	14.2	1000 sq ft floor area	20	$0.00	$273.35	$273.35	$416.78	$690.13	3
Furnace/AC - SEER 14	94	0.175	-0.001	-1.0	ton	15	$549.55	$642.17	$92.62	$235.85	$878.12	3
Furnace/AC - SEER 14 with 95 AFUE furnace	116	0.176	0.041	43.5	ton	15	$782.55	$1,389.59	$586.05	$799.57	$2,188.74	3
Furnace/AC - SEER 15	74	0.187	0.020	-2.2	ton	15	$549.55	$734.78	$185.24	$235.85	$970.74	3
Furnace/AC - SEER 15 with 95 AFUE furnace	120	0.187	0.045	41.6	ton	15	$782.55	$1,462.12	$679.57	$799.57	$2,246.36	3
Furnace/AC - SEER 16	26	0.164	-0.020	-3.0	ton	15	$549.55	$827.41	$277.86	$235.85	$1,063.26	3
Furnace/AC - SEER 16 with 95 AFUE furnace	98	0.164	0.000	40.1	ton	15	$782.55	$1,554.74	$772.19	$799.57	$2,340.98	3
Furnace/AC - SEER 17	46	0.182	-0.021	-3.0	ton	15	$549.55	$920.03	$370.47	$235.85	$1,155.88	3
Furnace/AC - SEER 17 with 95 AFUE furnace	142	0.192	0.045	38.2	ton	15	$782.55	$1,647.36	$864.81	$799.57	$2,433.60	3
Infiltration reduction - 10%	184	0.000	0.100	4.3	1000 sq ft cond floor area	13	$0.00	$20.00	$20.00	$100.00	$120.00	3
Infiltration reduction - 10% and attic insulation	891	0.121	0.437	52.5	1000 sq ft cond floor area	13	$0.00	$584.82	$584.82	$292.13	$876.95	3
Infiltration reduction - 15%	300	0.014	0.161	5.8	1000 sq ft cond floor area	13	$0.00	$20.00	$20.00	$100.00	$120.00	3
Infiltration reduction - 15% and attic insulation	980	0.130	0.480	38.6	1000 sq ft cond floor area	13	$0.00	$584.82	$584.82	$292.13	$876.95	3
RCA 10% improvement	44	0.095	0.000	0.0	ton	10	$0.00	$17.87	$17.87	$28.47	$46.33	3
RCA 15% improvement	69	0.152	0.000	0.0	ton	10	$0.00	$27.03	$27.03	$119.24	$146.27	3
RCA 5% improvement	25	0.054	0.000	0.0	ton	10	$0.00	$10.38	$10.38	$28.00	$38.38	3
Roof insulation	753	0.102	0.330	34.8	1000 sq ft roof area	20	$0.00	$584.82	$584.82	$182.13	$766.95	3
Setback thermostat - full setback	843	-0.005	-1.312	34.8	1000 sq ft cond floor area	9	$14.91	$25.65	$10.74	$7.72	$33.38	3
Setback thermostat - moderate setback	300	0.007	-0.847	14.0	1000 sq ft cond floor area	9	$14.91	$25.65	$10.74	$7.72	$33.38	3
Wall insulation	537	0.050	0.273	38.4	1000 sq ft wall area	30	$0.00	$151.98	$151.98	$1,170.84	$1,322.82	2.2
Whole House Fan	41	0.000	0.000	-0.1	1000 sq ft cond floor area	15	$0.00	$634.25	$634.25	$492.57	$1,126.82	3
Window Replacement	838	0.125	0.311	15.6	100 sq ft window area	20	$1,649.97	$2,068.60	$428.63	$205.97	$2,274.57	3.5

MW Proposed Technologies for Program	Target kWh percust	Target kW percust	Measure life	Incremental Costs YR1	Incentive	Size Basis	Avg Size	units
T-8 8ft 1 lamp	40	0.011	10	$50.00	$5.00			
T-8 8ft 2 lamp	74	0.020	10	$54.00	$7.00			
T-8 4ft 4 lamp	140	0.038	10	$57.00	$11.00			
T-8 4ft 3 lamp	118	0.032	10	$54.00	$9.00			
T-8 4ft 2 lamp	63	0.017	10	$36.00	$4.00			
T-8 4ft 1 lamp	52	0.014	10	$33.00	$3.00			
T-8 3ft 4 lamp	74	0.020	10	$57.00	$10.00			
T-8 3ft 3 lamp	44	0.012	10	$54.00	$6.50			
T-8 3ft 2 lamp	37	0.010	10	$36.00	$4.00			
T-8 3ft 1 lamp	40	0.011	10	$33.00	$3.00			
T-8 2ft 4 lamp	81	0.022	10	$57.00	$6.00			
T-8 2ft 3 lamp	74	0.020	10	$54.00	$4.20			
T-8 2ft 2 lamp	37	0.010	10	$36.00	$4.00			
T-8 2ft 1 lamp	29	0.008	10	$33.00	$3.00			
T-8 HO 8 ft 1 Lamp	92	0.025	10	$66.00	$10.00			
T-8 HO 8 ft 2 Lamp	184	0.050	10	$72.00	$14.00			
Low Watt T8 lamps	15	0.004	5	$2.00	$0.50			
LED Exit Signs Electronic Fixtures (Retrofit Only)	158	0.018	15	$25.00	$10.00			
CFL Fixture	294	0.080	12	$45.00	$10.00			
CFL Screw in	147	0.040	2	$3.00	$2.00			
1 Lamp T-5 with Elec Ballast replacing T-12	44	0.012	10	$59.30	$5.00			
2 Lamp T-5 *replacing* T-12	44	0.012	10	$74.12	$8.00			
3 Lamp T-5 replacing T-12	99	0.027	10	$78.60	$10.00			
4 Lamp T-5 replacing T-12	88	0.024	10	$87.56	$12.00			
1 Lamp T-5 HO with Elec Ballast replacing T-12	55	0.015	10	$120.00	$6.00			
2 Lamp T-5HO replacing T-12	70	0.019	10	$140.00	$9.00			
3 Lamp T-5HO replacing T-12	92	0.025	10	$175.00	$11.00			
4 Lamp T-5HO replacing T-12	216	0.052	10	$225.00	$13.00			
Occupancy Sensors under 500 W	427	0.120	12	$200.00	$20.00			
Occupancy Sensors over 500 W	1068	0.290	12	$100.00	$40.00			
LED Auto Traffic Signals	275	0.085	6	$50.00	$12.50			
LED Pedestrian Signals	150	0.044	8	$100.00	$25.00			
Light Tube	361	0.100	14	$500.00	$75.00			
High Bay 3L T5HO	449	0.108	10	$180.00	$40.00			
High Bay 4LT5HO	882	0.210	10	$192.00	$50.00			
High Bay 6L T5HO	374	0.090	10	$350.00	$40.00			
High Bay 6L T5HO - Double fixture replace 1000W HID	1456	0.350	10	$700.00	$120.00			
High Bay Fluorescent 4LF32T8	616	0.148	10	$160.00	$40.00			
High Bay Fluorescent 6LF32T8	961	0.231	10	$160.00	$50.00			
High Bay Fluorescent 8LF32T8	649	0.156	10	$200.00	$40.00			
High Bay Fluorescent 8LF32T8 - Double fixture replace 1000W HID	2005	0.482	10	$400.00	$120.00			
Central Lighting Control	11500	3.120	12	$2,700.00	$400.00			

Switching Controls for Multilevel Lighting	8000	2.440	12	$3,000.00	$400.00			
Daylight Sensor controls	14800	4.020	12	$3,000.00	$600.00			
Pulse Start Metal Halide -retrofit only	430	0.120	7	$150.00	$25.00			
42W 8 Lamp Hi Bay CFL	345	0.083	10	$395.00	$50.00			
HP Water Heater 10-50 MBH	21156	4.200	15	$4,000.00	$2,000.00		30,000	Btuh
HP Water Heater 50-100 MBH	52890	10.500	15	$7,000.00	$3,500.00		75,000	Btuh
HP Water Heater 100-300 MBH	141041	28.000	15	$10,000.00	$5,000.00		200,000	Btuh
HP Water Heater 300-500 MBH	282081	56.000	15	$14,000.00	$7,000.00		400,000	Btuh
HP Water Heater >500 MBH	423122	84.000	15	$18,000.00	$9,000.00		600,000	Btuh
Motors 1-5 HP - Incentives per HP	113	0.031	15	$93.00	$25.00		2.5	hp
Motors 7.5-20 HP - Incentives per HP	408	0.111	15	$267.00	$105.00		13.1	hp
Motors 25-100 HP - Incentives per HP	1056	0.287	15	$707.00	$271.43		54.3	hp
Motors 125-250 HP - Incentives per HP	2435	0.662	15	$1,607.00	$725.00		181.3	hp
Pumps HP 1.5	353	0.096	15	$350.00	$210.00			
Pumps HP 2	471	0.128	15	$350.00	$220.00			
Pumps HP 3	707	0.192	15	$350.00	$230.00			
Pumps HP 5	1178	0.320	15	$341.00	$240.00			
Pumps HP 7.5	1766	0.480	15	$498.00	$250.00			
Pumps HP 10	2355	0.640	15	$332.00	$260.00			
Pumps HP 15	3533	0.960	15	$585.00	$300.00			
Pumps HP 20	4710	1.280	15	$850.00	$400.00			
Commercial Clothes Washers - electric water heater	86	0.120	10	$240.00	$50.00			
Commercial Clothes Washers - gas water heater	9	0.030	10	$240.00	$50.00			
Plug Load Occupancy Sensors Document Stations	803	0.055	5	$150.00	$25.00			
Vending Equipment Controller	800	0.210	5	$160.00	$50.00			
Anti Sweat Heater Controls	1489	0.000	15	$250.00	$40.00	per door		
Efficient Refrigeration Condensor	120	0.118	15	$35.00	$12.00	per ton		
Night covers for displays	105	0.030	15	$35.00	$10.00	per lineal foot		
Engineered Nozzles - COMPRESS AIR	7343	3.680	15	$80.00	$20.00			
Barrel Wraps - Inj Mold & Extruders	50	0.010	5	$2.00	$1.00			
Pellet Dryer Tanks & Ducts 3 dia	98	0.020	5	$32.69	$15.00			
Pellet Dryer Tanks & Ducts 4 dia	134	0.030	5	$43.31	$20.00			
Pellet Dryer Tanks & Ducts 5 dia	175	0.040	5	$53.97	$25.00			
Pellet Dryer Tanks & Ducts 6 dia	216	0.050	5	$64.69	$30.00			
Pellet Dryer Tanks & Ducts 8 dia	304	0.080	5	$86.46	$40.00			
Head Pressure Control	1264	0.000	15	$80.00	$60.00	per ton		
ENERGY STAR Commercial Solid Door Refrigerators less than20ft3	905	0.103	12	$250.00	$70.00	per unit	12	ft³
ENERGY STAR Commercial Solid Door Refrigerators 20-48 ft3	1069	0.122	12	$500.00	$70.00	per unit	30	ft³
ENERGY STAR Commercial Solid Door Refrigerators more than 48ft3	1361	0.155	12	$900.00	$70.00	per unit	62	ft³
ENERGY STAR Commercial Solid Door Freezers less than 20ft3	520	0.059	12	$150.00	$70.00	per unit	12	ft³
ENERGY STAR Commercial Solid Door Freezers 20-48 ft3	507	0.058	12	$400.00	$70.00	per unit	30	ft³
ENERGY STAR Commercial Solid Door Freezers more than 48ft3	483	0.055	12	$700.00	$70.00	per unit	63	ft³
Energy Efficient Ice Machines less than500 lbs	1652	0.189	12	$600.00	$150.00	per unit	315	lb/24 hrs
Energy Efficient Ice Machines 500-1000 lbs	2695	0.308	12	$1,500.00	$250.00	per unit	704	lb/24 hrs
Energy Efficient Ice Machines more than 1000 lbs	6048	0.690	12	$2,000.00	$500.00	per unit	1454	lb/24 hrs

Renewalbes Commercial PV per kW	1208	0.470	20	$8,000.00	$2,500.00			

Commercial

Enter weights into turquoise cells. Weights need not sum to 1.0.

Climate	Weight	Normalized
Covington	1.000	[redacted]
Indianapolis	0.000	
Sum	1.000	

Building Type	Weight	Normalized	
Assembly	0.116	[redacted]	0.116
Big Box Retail	0.017		0.017
Fast Food	0.017		0.017
Full Service Restaurant	0.041		0.041
Grocery	1.000		0.000
Large Office	1.000		0.000
Light Industrial	0.008		0.008
Primary School	0.058		0.058
Small Office	0.174		0.174
Small Retail	0.554		0.554
Sum	2.983		

Some of the measures (cool roof, economizers, setback thermostats, high-performance windows, window film) were analyzed originally for small commercial buildings only. Set the large office weight to 0.

SNS added calcs

Measure	kWh/unit	kW/unit	therm/unit	Unit	Measure Life	Base Equipment Cost per Unit	Measure Equipment Cost per Unit	Incremental Equipment Cost per Unit	Labor Cost per Unit	Installed Cost per Unit	Typical size	Per Unit Savings	
AC <65,000 1 Ph	65	0.072	0.0	ton	15	$458.60	$514.18	$55.57	$141.57	$655.75	5.0		
AC <65,000 3 Ph	49	0.054	0.0	ton	15	$279.72	$398.61	$118.88	$402.78	$801.39	5.0		
AC >760,000	92	0.101	0.0	ton	15	$456.77	$555.15	$98.39	$111.43	$666.59	65.0		
AC 135,000 - 240,000	118	0.131	0.0	ton	15	$674.88	$785.77	$110.89	$187.71	$973.48	20.0		
AC 240,000 - 760,000	62	0.068	0.0	ton	15	$534.50	$649.63	$115.13	$185.71	$835.34	25.0		
AC 65,000 - 135,000	67	0.075	0.0	ton	15	$608.25	$757.38	$149.13	$224.54	$981.92	10.0		
Air-Cooled Recip Chiller COP = 2.8, IPLV = 3.41	123	0.019	0.0	ton	20	$445.90	$490.96	$45.07	$38.00	$528.96	200.0	123.4491916	24689.838
Air-Cooled Recip Chiller COP = 2.8, IPLV = 3.89	252	0.041	0.0	ton	20	$445.90	$537.94	$92.04	$38.00	$575.94	200.0	252.49532	50499.064
Air-Cooled Recip Chiller COP = 2.8, IPLV = 4.24	313	0.048	0.0	ton	20	$445.90	$565.48	$119.59	$38.00	$603.48	200.0	313.2286858	62645.737
Air-Cooled Recip Chiller COP = 3.08, IPLV = 3.36	137	0.101	0.0	ton	20	$445.90	$504.48	$58.58	$38.00	$542.48	200.0	137.1723522	27434.47
Air-Cooled Recip Chiller COP = 3.08, IPLV = 3.76	250	0.118	0.0	ton	20	$445.90	$545.58	$99.68	$38.00	$583.58	200.0	249.5580286	49911.606
Air-Cooled Recip Chiller COP = 3.08, IPLV = 4.28	367	0.138	0.0	ton	20	$445.90	$587.52	$141.63	$38.00	$625.52	200.0	367.0378317	73407.566
Air-Cooled Recip Chiller COP = 3.08, IPLV = 4.67	422	0.144	0.0	ton	20	$445.90	$612.85	$166.96	$38.00	$650.85	200.0	422.3266275	84465.325
Air-Cooled Recip Chiller COP = 3.36, IPLV = 3.66	253	0.186	0.0	ton	20	$445.90	$552.13	$106.23	$38.00	$590.13	200.0	252.9134819	50582.696
Air-Cooled Recip Chiller COP = 3.36, IPLV = 4.10	356	0.201	0.0	ton	20	$445.90	$590.19	$144.29	$38.00	$628.19	200.0	355.9624657	71192.493
Air-Cooled Recip Chiller COP = 3.36, IPLV = 4.67	464	0.220	0.0	ton	20	$445.90	$628.84	$182.94	$38.00	$666.84	200.0	463.6823352	92736.467
Air-Cooled Recip Chiller COP = 3.36, IPLV = 5.09	514	0.225	0.0	ton	20	$445.90	$651.77	$205.88	$38.00	$689.77	200.0	514.3764286	102875.29
Air-Cooled Screw Chiller COP = 2.8, IPLV = 3.46	133	0.022	0.0	ton	20	$445.90	$496.46	$50.57	$38.00	$534.46	200.0	133.2412914	26648.258
Air-Cooled Screw Chiller COP = 2.8, IPLV = 3.64	185	0.040	0.0	ton	20	$445.90	$515.02	$69.12	$38.00	$553.02	200.0	185.2355806	37047.116
Air-Cooled Screw Chiller COP = 2.8, IPLV = 4.75	362	0.060	0.0	ton	20	$445.90	$598.36	$152.46	$38.00	$636.36	200.0	361.713462	72342.692
Air-Cooled Screw Chiller COP = 3.08, IPLV = 3.36	138	0.101	0.0	ton	20	$445.90	$504.48	$58.58	$38.00	$542.48	200.0	137.5803564	27516.071
Air-Cooled Screw Chiller COP = 3.08, IPLV = 3.80	259	0.121	0.0	ton	20	$445.90	$549.21	$103.31	$38.00	$587.21	200.0	258.8794846	51775.897
Air-Cooled Screw Chiller COP = 3.08, IPLV = 4.00	306	0.138	0.0	ton	20	$445.90	$566.29	$120.40	$38.00	$604.29	200.0	306.2147388	61242.948
Air-Cooled Screw Chiller COP = 3.08, IPLV = 5.22	467	0.156	0.0	ton	20	$445.90	$642.14	$196.24	$38.00	$680.14	200.0	466.873571	93374.714
Air-Cooled Screw Chiller COP = 3.36, IPLV = 3.66	254	0.186	0.0	ton	20	$445.90	$552.13	$106.23	$38.00	$590.13	200.0	253.6651576	50733.032
Air-Cooled Screw Chiller COP = 3.36, IPLV = 4.1!	365	0.204	0.0	ton	20	$445.90	$594.00	$148.11	$38.00	$632.00	200.0	364.8877683	72977.554
Air-Cooled Screw Chiller COP = 3.36, IPLV = 4.42	408	0.220	0.0	ton	20	$445.90	$613.11	$167.22	$38.00	$651.11	200.0	408.2902686	81658.054
Air-Cooled Screw Chiller COP = 3.36, IPLV = 5.69	556	0.236	0.0	ton	20	$445.90	$678.67	$232.77	$38.00	$716.67	200.0	555.6000852	111120.02
Anti Sweat Heater Control	1,644	0.006	0.0	door	12	$0.00	$0.00	$0.00	$30.00	$30.00	100.0		
CHW reset 10 deg with air-cooled chiller	4	0.002	0.3	ton	5	$0.00	$0.41	$0.41	$0.39	$0.79	200.0		
CHW reset 10 deg with water-cooled chiller	12	-0.001	0.3	ton	5	$0.00	$0.41	$0.41	$0.39	$0.79	230.0		
CHW reset 5 deg with air-cooled chiller	3	0.002	0.2	ton	5	$0.00	$0.41	$0.41	$0.39	$0.79	200.0		
CHW reset 5 deg with water-cooled chiller	11	-0.001	0.2	ton	5	$0.00	$0.41	$0.41	$0.39	$0.79	230.0		
Cool roof	188	0.128	-20.7	1000 sq ft roof area	20	$0.00	$664.88	$664.88	$7,789.79	$8,454.67	0.0		
Economizer	353	0.000	0.6	ton	15	$0.00	$126.76	$126.76	$43.34	$170.11	10.0		
Efficient Condenser	1,280	0.123	0.0	ton	15	$0.00	$652.75	$652.75	$152.68	$805.43	70.0		
Floating Head Pressure Control	1,607	0.000	0.0	ton	16	$0.00	$10.04	$10.04	$40.92	$50.95	70.0		
GSHP <135,000 17EER	209	0.109	0.0	ton	15	$561.14	$740.93	$179.79	$229.97	$970.90	10.0		
GSHP <135,000 19EER	286	0.152	0.0	ton	15	$561.14	$740.93	$179.79	$229.97	$970.90	10.0		
GSHP <135,000 EER 17 ASHP base	778	0.301	0.0	ton	15	$630.00	$7,500.00	$6,870.00	$0.00	$7,500.00	10.0		
GSHP <135,000 EER 19 ASHP base	856	0.344	0.0	ton	15	$630.00	$7,500.00	$6,870.00	$0.00	$7,500.00	10.0		
High Performance Glazing	687	0.345	3.5	100 sqft glazing	20	$3,320.95	$4,716.64	$1,395.69	$491.77	$5,208.41	0.0		
HP <65,000 1 Ph	114	0.076	0.0	ton	15	$514.90	$588.41	$73.52	$141.57	$729.98	5.0		
HP <65,000 3 Ph	65	0.054	0.0	ton	15	$363.18	$549.68	$186.50	$207.35	$757.03	5.0		
HP >240,000	175	0.124	0.0	ton	15	$696.25	$826.08	$129.83	$185.71	$1,011.79	25.0		
HP 135,000 - 240,000	144	0.090	0.0	ton	15	$949.56	$1,075.00	$125.44	$187.71	$1,262.71	20.0		
HP 65,000 - 135,000	124	0.093	0.0	ton	15	$837.81	$1,020.24	$182.43	$224.54	$1,244.78	10.0		
Night Covers	24	-0.005	0.0	LF of case	5	$0.00	$33.75	$33.75	$3.79	$37.54	230.0		
PTAC	32	0.028	0.0	ton	15	$494.54	$605.02	$110.48	$88.33	$693.36	0.8		
PTAC-HP	56	0.035	0.0	ton	15	$617.17	$755.05	$137.88	$268.40	$1,023.45	0.8		
Refrigerant charging correction	96	0.106	0.0	ton	10	$0.00	$10.36	$10.36	$28.00	$38.36	10.0		
Setback/Setup	1,008	-0.038	160.6	1000 sq ft cond floor area	9	$32.77	$82.48	$49.71	$92.29	$174.76	0.0		
VFD Fan	1,443	0.179	-7.7	per fan hp	10	$0.00	$155.96	$155.96	$65.93	$221.88	250.0		
VFD Pump	2,757	0.190	8.3	per CHW pump hp	10	$0.00	$149.14	$149.14	$63.15	$212.29	40.0		
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0	309	0.122	0.0	ton	20	$267.71	$397.90	$130.19	$25.00	$422.90	1,000.0	309.1046272	309104.63

Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0	269	0.118	0.0 ton	20	$267.71	$385.97	$118.26	$25.00	$410.97	1,000.0	269.4977505	269497.75
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0	249	0.116	0.0 ton	20	$267.71	$380.55	$112.83	$25.00	$405.55	1,000.0	249.1771119	249177.11
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0	231	0.114	0.0 ton	20	$267.71	$375.12	$107.41	$25.00	$400.12	1,000.0	230.7542852	230754.29
Water-Cooled cent Chiller > 300 ton 0.46 kW/ton with 0	170	0.108	0.0 ton	20	$267.71	$359.93	$92.22	$25.00	$384.93	1,000.0	170.0056827	170005.68
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0	242	0.070	0.0 ton	20	$267.71	$356.54	$88.82	$25.00	$381.54	1,000.0	241.973553	241973.55
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0	197	0.065	0.0 ton	20	$267.71	$343.11	$75.40	$25.00	$368.11	1,000.0	197.2285327	197228.53
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0	174	0.063	0.0 ton	20	$267.71	$337.01	$69.30	$25.00	$362.01	1,000.0	174.3108884	174310.89
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0	153	0.061	0.0 ton	20	$267.71	$330.91	$63.20	$25.00	$355.91	1,000.0	153.4925186	153492.52
Water-Cooled cent Chiller > 300 ton 0.52 kW/ton with 0	85	0.054	0.0 ton	20	$267.71	$313.82	$46.11	$25.00	$338.82	1,000.0	84.97321448	84973.214
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0	175	0.017	0.0 ton	20	$267.71	$315.18	$47.46	$25.00	$340.18	1,000.0	174.6139288	174613.93
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0	125	0.013	0.0 ton	20	$267.71	$300.26	$32.54	$25.00	$325.26	1,000.0	124.8797456	124879.75
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0	99	0.010	0.0 ton	20	$267.71	$293.48	$25.76	$25.00	$318.48	1,000.0	99.3600167	99360.017
Water-Cooled cent Chiller > 300 ton 0.58 kW/ton with 0	76	0.008	0.0 ton	20	$267.71	$286.70	$18.98	$25.00	$311.70	1,000.0	76.21212935	76212.129
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton wi	334	0.133	0.0 ton	20	$338.77	$500.62	$161.85	$45.00	$545.62	230.0	334.2671409	76881.442
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton wi	291	0.129	0.0 ton	20	$338.77	$488.01	$149.24	$45.00	$533.01	230.0	290.7105808	66863.434
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton wi	268	0.126	0.0 ton	20	$338.77	$482.28	$143.51	$45.00	$527.28	230.0	268.3617721	61723.208
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton wi	248	0.124	0.0 ton	20	$338.77	$476.54	$137.78	$45.00	$521.54	230.0	248.0885365	57060.363
Water-Cooled cent Chiller 150 - 300 ton 0.51 kW/ton wi	186	0.118	0.0 ton	20	$338.77	$461.64	$122.87	$45.00	$506.64	230.0	185.7807148	42729.564
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton wi	261	0.076	0.0 ton	20	$338.77	$444.06	$105.29	$45.00	$489.06	230.0	260.6113861	59940.619
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton wi	211	0.071	0.0 ton	20	$338.77	$429.87	$91.10	$45.00	$474.87	230.0	211.427416	48628.306
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton wi	186	0.068	0.0 ton	20	$338.77	$423.42	$84.65	$45.00	$468.42	230.0	186.1785612	42821.069
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton wi	163	0.066	0.0 ton	20	$338.77	$416.97	$78.20	$45.00	$461.97	230.0	163.2812324	37554.683
Water-Cooled cent Chiller 150 - 300 ton 0.57 kW/ton wi	93	0.059	0.0 ton	20	$338.77	$400.20	$61.44	$45.00	$445.20	230.0	92.91151945	21369.649
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton wi	187	0.018	0.0 ton	20	$338.77	$387.49	$48.73	$45.00	$432.49	230.0	187.250207	43067.548
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton wi	132	0.013	0.0 ton	20	$338.77	$371.73	$32.96	$45.00	$416.73	230.0	132.1594879	30396.682
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton wi	104	0.010	0.0 ton	20	$338.77	$364.56	$25.80	$45.00	$409.56	230.0	103.9919643	23918.152
Water-Cooled cent Chiller 150 - 300 ton 0.63 kW/ton wi	78	0.008	0.0 ton	20	$338.77	$357.40	$18.63	$45.00	$402.40	230.0	78.443455	18041.995
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton	378	0.148	0.0 ton	20	$468.69	$671.72	$203.03	$98.00	$769.72	80.0	377.6696413	30213.571
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton	329	0.144	0.0 ton	20	$468.69	$660.11	$191.42	$98.00	$758.11	80.0	329.1510057	26332.08
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton	304	0.141	0.0 ton	20	$468.69	$654.84	$186.15	$98.00	$752.84	80.0	304.2458225	24339.666
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton	282	0.139	0.0 ton	20	$468.69	$649.56	$180.87	$98.00	$747.56	80.0	281.6532271	22532.258
Water-Cooled Centrifugal Chiller < 150 ton 0.56 kW/ton	207	0.132	0.0 ton	20	$468.69	$634.79	$166.10	$98.00	$732.79	80.0	207.2711911	16581.695
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton	296	0.085	0.0 ton	20	$468.69	$593.28	$124.60	$98.00	$691.28	80.0	296.1433001	23691.464
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton	241	0.080	0.0 ton	20	$468.69	$580.23	$111.54	$98.00	$678.23	80.0	241.1067558	19288.54
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton	213	0.077	0.0 ton	20	$468.69	$574.29	$105.60	$98.00	$672.29	80.0	212.9646267	17037.17
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton	187	0.074	0.0 ton	20	$468.69	$568.36	$99.67	$98.00	$666.36	80.0	187.4567485	14996.54
Water-Cooled Centrifugal Chiller < 150 ton 0.63 kW/ton	103	0.066	0.0 ton	20	$468.69	$551.74	$83.05	$98.00	$649.74	80.0	103.4705316	8277.6425
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton \	215	0.021	0.0 ton	20	$468.69	$514.85	$46.16	$98.00	$612.85	80.0	214.6068011	17168.544
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton \	153	0.015	0.0 ton	20	$468.69	$500.34	$31.65	$98.00	$598.34	80.0	153.2825911	12262.607
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton \	122	0.012	0.0 ton	20	$468.69	$493.75	$25.06	$98.00	$591.75	80.0	121.8205609	9745.6449
Water-Cooled Centrifugal Chiller < 150 ton 0.7 kW/ton \	94	0.009	0.0 ton	20	$468.69	$487.15	$18.46	$98.00	$585.15	80.0	93.50067068	7480.0537
Water-cooled screw chiller < 150 ton 0.63 kW/ton with (	380	0.182	0.0 ton	20	$443.39	$637.38	$193.99	$76.00	$713.38	80.0	379.5319009	30362.552
Water-cooled screw chiller < 150 ton 0.63 kW/ton with (	355	0.177	0.0 ton	20	$443.39	$623.12	$179.73	$76.00	$699.12	80.0	354.8061717	28384.494
Water-cooled screw chiller < 150 ton 0.63 kW/ton with (	326	0.172	0.0 ton	20	$443.39	$608.85	$165.46	$76.00	$684.85	80.0	325.5466868	26043.735
Water-cooled screw chiller < 150 ton 0.63 kW/ton with (	294	0.166	0.0 ton	20	$443.39	$594.59	$151.20	$76.00	$670.59	80.0	293.9424478	23515.396
Water-cooled screw chiller < 150 ton 0.63 kW/ton with (	271	0.162	0.0 ton	20	$443.39	$583.17	$139.78	$76.00	$659.17	80.0	271.1450038	21691.6
Water-cooled screw chiller < 150 ton 0.63 kW/ton with (	206	0.152	0.0 ton	20	$443.39	$554.64	$111.25	$76.00	$630.64	80.0	206.3315964	16506.528
Water-cooled screw chiller < 150 ton 0.71 kW/ton with (	298	0.109	0.0 ton	20	$443.39	$592.10	$148.71	$76.00	$668.10	80.0	298.0072527	23840.58
Water-cooled screw chiller < 150 ton 0.71 kW/ton with (	270	0.104	0.0 ton	20	$443.39	$576.05	$132.66	$76.00	$652.05	80.0	270.1596992	21612.776
Water-cooled screw chiller < 150 ton 0.71 kW/ton with (	237	0.098	0.0 ton	20	$443.39	$560.00	$116.61	$76.00	$636.00	80.0	237.2400276	18979.202
Water-cooled screw chiller < 150 ton 0.71 kW/ton with (	202	0.092	0.0 ton	20	$443.39	$543.95	$100.56	$76.00	$619.95	80.0	201.6793333	16134.347
Water-cooled screw chiller < 150 ton 0.71 kW/ton with (	176	0.088	0.0 ton	20	$443.39	$531.11	$87.72	$76.00	$607.11	80.0	176.0089306	14080.714
Water-cooled screw chiller < 150 ton 0.71 kW/ton with (	103	0.076	0.0 ton	20	$443.39	$499.02	$55.63	$76.00	$575.02	80.0	103.0642204	8245.1376
Water-cooled screw chiller < 150 ton 0.79 kW/ton with (	217	0.037	0.0 ton	20	$443.39	$546.81	$103.43	$76.00	$622.81	80.0	216.7111545	17336.892
Water-cooled screw chiller < 150 ton 0.79 kW/ton with (	186	0.031	0.0 ton	20	$443.39	$528.98	$85.59	$76.00	$604.98	80.0	185.7773289	14862.186
Water-cooled screw chiller < 150 ton 0.79 kW/ton with (	149	0.025	0.0 ton	20	$443.39	$511.15	$67.76	$76.00	$587.15	80.0	149.1906988	11935.256
Water-cooled screw chiller < 150 ton 0.79 kW/ton with (	110	0.018	0.0 ton	20	$443.39	$493.32	$49.93	$76.00	$569.32	80.0	110.0544659	8804.3573
Water-cooled screw chiller < 150 ton 0.79 kW/ton with (	81	0.013	0.0 ton	20	$443.39	$479.05	$35.66	$76.00	$555.05	80.0	81.08447776	6486.7582
Water-cooled screw chiller > 300 ton 0.51 kW/ton with (	307	0.147	0.0 ton	20	$275.84	$389.89	$114.05	$37.00	$426.89	1,000.0	307.2542183	307254.22
Water-cooled screw chiller > 300 ton 0.51 kW/ton with (	287	0.143	0.0 ton	20	$275.84	$379.86	$104.02	$37.00	$416.86	1,000.0	287.2298482	287229.85
Water-cooled screw chiller > 300 ton 0.51 kW/ton with (	264	0.139	0.0 ton	20	$275.84	$369.83	$93.99	$37.00	$406.83	1,000.0	263.5334408	263533.44
Water-cooled screw chiller > 300 ton 0.51 kW/ton with (	238	0.134	0.0 ton	20	$275.84	$359.80	$83.96	$37.00	$396.80	1,000.0	237.9307566	237930.76
Water-cooled screw chiller > 300 ton 0.51 kW/ton with (	219	0.131	0.0 ton	20	$275.84	$351.77	$75.93	$37.00	$388.77	1,000.0	219.4825354	219482.54
Water-cooled screw chiller > 300 ton 0.51 kW/ton with (	167	0.123	0.0 ton	20	$275.84	$331.71	$55.87	$37.00	$368.71	1,000.0	167.0345321	167034.53
Water-cooled screw chiller > 300 ton 0.58 kW/ton with (	241	0.088	0.0 ton	20	$275.84	$369.22	$93.39	$37.00	$406.22	1,000.0	241.2083336	241208.33
Water-cooled screw chiller > 300 ton 0.58 kW/ton with (	219	0.084	0.0 ton	20	$275.84	$357.94	$82.10	$37.00	$394.94	1,000.0	218.6936145	218693.61
Water-cooled screw chiller > 300 ton 0.58 kW/ton with (	192	0.080	0.0 ton	20	$275.84	$346.65	$70.82	$37.00	$383.65	1,000.0	192.0649946	192064.99
Water-cooled screw chiller > 300 ton 0.58 kW/ton with (	163	0.074	0.0 ton	20	$275.84	$335.37	$59.53	$37.00	$372.37	1,000.0	163.301548	163301.55
Water-cooled screw chiller > 300 ton 0.58 kW/ton with (	143	0.071	0.0 ton	20	$275.84	$326.34	$50.51	$37.00	$363.34	1,000.0	142.533967	142533.97
Water-cooled screw chiller > 300 ton 0.58 kW/ton with (	84	0.062	0.0 ton	20	$275.84	$303.77	$27.94	$37.00	$340.77	1,000.0	83.54435345	83544.353
Water-cooled screw chiller > 300 ton 0.64 kW/ton with (	175	0.030	0.0 ton	20	$275.84	$348.56	$72.72	$37.00	$385.56	1,000.0	175.1709137	175170.91
Water-cooled screw chiller > 300 ton 0.64 kW/ton with (	150	0.025	0.0 ton	20	$275.84	$336.02	$60.18	$37.00	$373.02	1,000.0	150.1675386	150167.54
Water-cooled screw chiller > 300 ton 0.64 kW/ton with (	121	0.020	0.0 ton	20	$275.84	$323.48	$47.65	$37.00	$360.48	1,000.0	120.5779259	120577.93
Water-cooled screw chiller > 300 ton 0.64 kW/ton with (	89	0.014	0.0 ton	20	$275.84	$310.94	$35.11	$37.00	$347.94	1,000.0	88.60631375	88606.314
Water-cooled screw chiller > 300 ton 0.64 kW/ton with (	66	0.010	0.0 ton	20	$275.84	$300.91	$25.08	$37.00	$337.91	1,000.0	65.56169717	65561.697
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton w	345	0.165	0.0 ton	20	$346.94	$496.35	$149.41	$53.00	$549.35	230.0	344.827846	79310.405
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton w	322	0.161	0.0 ton	20	$346.94	$484.30	$137.36	$53.00	$537.30	230.0	322.3656088	74144.09

Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton w	296	0.156	0.0 ton	20	$346.94	$472.25	$125.31	$53.00	$525.25	230.0	295.7962426	68033.136
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton w	267	0.151	0.0 ton	20	$346.94	$460.20	$113.26	$53.00	$513.20	230.0	267.078506	61428.056
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton w	246	0.147	0.0 ton	20	$346.94	$450.56	$103.62	$53.00	$503.56	230.0	246.3752576	56666.309
Water-cooled screw chiller 150 - 300 ton 0.57 kW/ton w	188	0.138	0.0 ton	20	$346.94	$426.46	$79.52	$53.00	$479.46	230.0	187.5210811	43129.849
Water-cooled screw chiller 150 - 300 ton 0.65 kW/ton w	271	0.099	0.0 ton	20	$346.94	$465.32	$118.38	$53.00	$518.32	230.0	270.7285348	62267.563
Water-cooled screw chiller 150 - 300 ton 0.65 kW/ton w	245	0.095	0.0 ton	20	$346.94	$451.77	$104.83	$53.00	$504.77	230.0	245.4627504	56456.433
Water-cooled screw chiller 150 - 300 ton 0.65 kW/ton w	216	0.089	0.0 ton	20	$346.94	$438.21	$91.27	$53.00	$491.21	230.0	215.5684043	49580.733
Water-cooled screw chiller 150 - 300 ton 0.65 kW/ton w	183	0.084	0.0 ton	20	$346.94	$424.66	$77.72	$53.00	$477.66	230.0	183.2548136	42148.607
Water-cooled screw chiller 150 - 300 ton 0.65 kW/ton w	160	0.079	0.0 ton	20	$346.94	$413.81	$66.87	$53.00	$466.81	230.0	159.979954	36795.389
Water-cooled screw chiller 150 - 300 ton 0.65 kW/ton w	94	0.069	0.0 ton	20	$346.94	$386.70	$39.76	$53.00	$439.70	230.0	93.74784332	21562.004
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton w	197	0.034	0.0 ton	20	$346.94	$434.30	$87.36	$53.00	$487.30	230.0	196.7223367	45246.137
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton w	169	0.028	0.0 ton	20	$346.94	$419.24	$72.30	$53.00	$472.24	230.0	168.6563909	38790.97
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton w	135	0.023	0.0 ton	20	$346.94	$404.18	$57.24	$53.00	$457.18	230.0	135.4032056	31142.737
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton w	100	0.016	0.0 ton	20	$346.94	$389.11	$42.17	$53.00	$442.11	230.0	99.53269896	22892.521
Water-cooled screw chiller 150 - 300 ton 0.72 kW/ton w	74	0.012	0.0 ton	20	$346.94	$377.07	$30.12	$53.00	$430.07	230.0	73.61850956	16932.257
Window Film	549	0.342	-100.8 100 sqft glazing	10	$0.00	$89.89	$89.89	$63.92	$153.81	0.0		
WLHP <17,000	36	0.024	-0.2 ton	15	$561.14	$583.14	$22.00	$229.97	$813.11	1.0		
WLHP 17,000-65,000	31	0.021	-0.2 ton	15	$561.14	$587.42	$26.29	$229.97	$817.40	3.0		
WLHP 65,000-135,000	31	0.021	-0.2 ton	15	$561.14	$588.20	$27.06	$229.97	$818.17	7.5		
Water-Cooled Chiller 150-300 ton	310	0.151	0.0 ton	20	$0.00	$0.00	$0.00	$0.00	$0.00	230.0		
Water-Cooled Chiller >300 ton	260	0.125	0.0 ton	20	$0.00	$0.00	$0.00	$0.00	$0.00	1,000.0		
Water-Cooled Chiller <150 ton	92	0.045	0.0 ton	20	$0.00	$0.00	$0.00	$0.00	$0.00	80.0		
Air-cooled Chiller	218	0.124	0.0 ton	20	$445.90	$488.24	$42.34	$38.00	$526.24	200.0	217.520316	43504.063

FES-L20 LED Case Lighting

Technology Description

Reach-in refrigerated coolers and freezers are a popular display system in supermarkets and convenience stores today. These cases are traditionally illuminated with vertically-installed T8 or T12 fluorescent lights between doors to provide illumination of the product within. LED lighting technology has now been adapted to serve in this environment, providing equal or better illumination with lower power input and less heat dissipation as compared to the currently available fluorescent technologies. Controls for LED case lights effectively save energy by turning off lights when unnecessary.

Methodology and Assumptions

The analysis for this technology was performed to evaluate the use of LED case lighting versus traditional fluorescent fixtures in refrigerated coolers and freezers.

LED's were compared to F58T8 fixtures. The option of adding sensors to the LED fixtures was also explored.

Key assumptions:

- 68% hour reduction with the addition of sensors

Results Summary

The results of the analysis are shown in FES-L20 LED Case Lights.

Replacing F58T8 case lights with LED fixtures results in a 0.039 kW and 460 kWh reduction. Adding sensors to the LED fixtures provides an additional 0.026 kW and 309 kWh savings.

Measure Life

Measure life for LED case lighting is shown to be 16 years.

Coincidence Factor

CF= 0.74

Initial One-Time Costs

LED case lights typically cost $250-350 per door. The sensors for the lighting are $19-22 per door.

Requirements For Application

Must replace case lighting on a one-for-one basis. Fixtures must be intended for coolers or freezers.

Existing Energy Standards

There are currently no standards for this technology.

Sources of Information

Focus on Energy, manufacturers' data

Attachments

- FES-L20 LED Case Lights

FES-L20 LED Case Lighting

Assumptions:

Base Case: F58T8 fluorescent lamps with electronic ballasts (applies to both new const
74 watts (average per door, which includes N+1 lamps per N-dooi
8760 annual operating hours (Typical - case lighting is usually opera

New Technology: 2-NuaLight CryoLED2 60" fixtures or GE Gelcore units selected for proper r
36 watts (Nualight (per door))
37.5 watts (Gelcore (per door))
0.41 Interaction factor based on effective refrigeration compressor E
0.74 Coincidence Factor

Occupancy Sensors:
Assume 68% reduction of operating hours

EXISTING

	F58T8 Case Lights
Lighting watts/door	*74*
Interaction Factor	*0.41*
Coincidence Factor	*0.74*
Annual hours	*8760*
Peak kW	***0.077***
Annual kWh	***914***

	LED Case Lights w/o Sensors
kW/door	*0.037*
Annual Hours	*8760*
Peak kW	***0.038***
Annual kWh	***454***

PROPOSED

	LED Case Lights
Lighting watts/door	*37*
Interaction Factor	*0.41*
Coincidence Factor	*0.74*
Annual hours	*8760*
Peak kW	***0.038***
Annual kWh	***454***

	LED Case Lights w/ Sensors
kW/door	*0.037*
Annual Hours	*2803*
Peak kW	***0.038***
Annual kWh	***145***

SAVINGS

Peak kW	***0.039***
Annual kWh	***460***

Peak kW	***0.026***
Annual kWh	***309***

. & retrofit)
r case. Source: Zero-Zone)
ited 24/7 to support stocking during closed hours)

etrofit

EER value of 6.7 and 5.25 Btu/Wh, respectively

FES-L6A Residential Compact Fluorescent Lighting

The conversion of incandescent lamps/fixtures to compact fluorescent lamps/fixture is evaluated.
Assumptions:
- 13,14,15&16W CFLs are assumed to be the replacement for a 60 W incandescent lamp
- 20 W CFLs are assumed to be the replacement for a 75 W incandescent lamp
- 26&27W CFLs are assumed to be the replacement for a 100W incandescent lamp
- Annual hours of operation of 840 (2.3*x365) assumed
- A coincidence factor of 0.08 was assumed for summer peak

	Average size Analysis				Specific Wattage Analysis	
EXISTING						
Lighting Type	60W Inc	75W Inc	100W Inc		60W Inc	75W Inc
Number of Fixtures	1	1	1		1	1
Lamps per Fixture	1	1	1		1	1
Fixture Wattage	60	75	100		60	75
CF - Coincidence Factor	0.08	0.08	0.08		0.08	0.08
Annual Operating Hours	840	840	840		840	840
Conversion Factor	1,000	1,000	1,000		1,000	1,000
kW	0.060	0.075	0.100		0.060	0.075
kWh/Yr Use	50	63	84		50	63
PROPOSED						
Lighting Type	14.5W CFL	20W CFL	26.5W CFL		13W CFL	20W CFL
Number of Fixtures	1	1	1		1	1
Lamps per Fixture	1	1	1		1	1
Fixture Wattage	14.5	20.0	26.5		13.0	20.0
Conversion Factor	1,000	1,000	1,000		1,000	1,000
kW	0.015	0.020	0.027		0.013	0.020
kWh/Yr Use	12	17	22		11	17
SAVINGS				weighted avg		
Avg non-coincident kW	0.0455	0.0550	0.0735	0.0525	0.0470	0.0550
Coincident kW	0.0036	0.0044	0.0059	0.0042	0.0038	0.0044
kWh/Yr Use	38	46	62	44.1	39	46
weighting**	68.0%	10.3%	21.6%			

*Hours per day from KEMA-XENERGY. CFL Metering Study: Final Report 2005
**weighting values from Glacier-CFL Delta Watts Analysis 2008

Duke Energy Master Measure Database

Commercial Measures

Measure Code Technology Rider Version	Proposed Technologies for Standard Lamps	Base Efficiency Level	Proposed Efficiency Level	Assumed hours of operation adjusting for interactive								Base Lamps			Custom Notes		Cost
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	Original/Actual Assumed Hours of Operation	Hours Notes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Not in Ohio TRM. FES calculation adjusted for TRM assumptions	4144	4144 actual hours, 3790 equivalent hours for DSMore, HVAC interactive factor for kWh is 0.097, for kW is 0.2
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DEER 2005	Total cost includes installation cost	FES calculation adjusted for TRM assumptions	4144	4144 actual hours, 3790 equivalent hours for DSMore, HVAC interactive factor for kWh is 0.097, for kW is 0.2
Engineering Judgment	Total cost includes installation cost	FES calculation adjusted for TRM assumptions	4144	4144 actual hours, 3790 equivalent hours for DSMore, HVAC interactive factor for kWh is 0.097, for kW is 0.2
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Engineering Judgment	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM, adjusted CF from 1.0 to 0.77	4144	4144 actual hours, 3790 equivalent hours for DSMore, HVAC interactive factor for kWh is 0.097, for kW is 0.2
DEER 2005, [illegible]	Total cost is an incremental equipment cost and does not include installation cost	Not in Ohio TRM. FES calculation adjusted for TRM assumptions	4144	4144 actual hours, 3270 equivalent hours for DSMore, HVAC interactive factor for kWh is 0.117, for kW is 0.2
Manufacturer [illegible]	Total cost includes installation cost	Used Ohio TRM	3833	No hours changes
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Manufacturer [illegible]	Total cost includes installation cost	Used Ohio TRM	3647	No hours changes
Manufacturer [illegible]	Total cost includes installation cost	Used Ohio TRM	8760	No hours changes
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Manufacturer [illegible]	Total cost includes installation cost	Not in Ohio TRM. FES calculation	3833	hours of savings used instead of hours of operation
Manufacturer [illegible]	Total cost includes installation cost	Not in Ohio TRM. FES calculation adjusted for TRM assumptions	[illegible]	hours of savings used instead of hours of operation
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DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM, adjusted CF from 1.0 to 0.77	4144	4144 actual hours, 3790 equivalent hours for DSMore, HVAC interactive factor for kWh is 0.097, for kW is 0.2
DEER 2005 for CFL install	Total cost is an incremental equipment cost and does not include installation cost	Not in Ohio TRM. FES calculation adjusted for TRM assumptions	4144	4144 actual hours, 3790 equivalent hours for DSMore, HVAC interactive factor for kWh is 0.097, for kW is 0.2
DEER 2005	Total cost includes installation cost	Used Ohio TRM	8760	No hours changes
Means [illegible] Cost Data, Engineering Judgment	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculation, TRM calculation leads to savings values that seem to large	3235	No hours changes
Means [illegible] Cost Data, Engineering Judgment	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculation, TRM calculation leads to savings values that seem to large	5550	No hours changes
Means [illegible] Cost Data, Engineering Judgment	Total cost includes stated installation costs	Used Ohio TRM, adjusted CF from 1.0 to 0.77	2400	Incorrectly listed as 4144 hours in previous version
Means [illegible] Cost Data, Engineering Judgment	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
Means [illegible] Cost Data, Engineering Judgment	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculation because TRM method uses factors not typically available baseline and new equipment (1A factors)	1235	No hours changes
RSMeans Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculation because TRM method uses factors not typically available baseline and new equipment (1A factors)	1235	No hours changes
DEER [illegible]	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculation because TRM method uses factors not typically available baseline and new equipment (1A factors)	1235	Typical commercial hours of use used instead of [illegible] equipment hours
DEER [illegible]	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculation because TRM method uses factors not typically available baseline and new equipment (1A factors)	1235	Typical commercial hours of use used instead of [illegible] equipment hours
Engineering Judgment	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for Indiana, consistent with TRM	248	No hours changes
Engineering Judgment	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for Indiana, consistent with TRM	948	No hours changes
Engineering Judgment	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for Indiana, consistent with TRM	348	No hours changes
Engineering Judgment	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for Indiana, consistent with TRM	348	No hours changes
Engineering Judgment	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for Indiana, consistent with TRM	338	No hours changes
Engineering Judgment	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for Indiana, consistent with TRM	938	No hours changes

engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3115	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3325	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3325	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3115	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3115	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3115	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3625	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3625	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3625	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3625	No hours changes
engineering judgement	Total cost includes stated installation costs	Used existing calculation methodology, hours updated for led analysis, consistent with TRM	3625	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used existing savings values and methodology. TRM provides insufficient information	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used existing savings values and methodology. TRM provides insufficient information	3683	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used existing savings values and methodology. TRM provides insufficient information	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used existing savings values and methodology. TRM provides insufficient information	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings values and methodology. Savings factor in TRM seems to high. FES savings factor based on equipment selection study	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used FES calculation methodology with TRM hours assumption. Assumed 50% year round use and 50% seasonal use	2915	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM methodology but with hours from FES calculations. TRM assumptions for hours based on HVAC equipment not process	3680	No hours changes
engineering judgement	Total cost includes stated installation costs	Used Ohio TRM	4380	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	990	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
DEER 2005	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	950	No hours changes
[illegible] installation cost		Used Ohio TRM but needed to add connected equipment and hours assumptions to algorithm	4380	Hours revised to equal kWh/kW
from DEER 2005, source engineering judgement	Total cost includes stated installation costs	Used Ohio TRM	3810	No hours changes
from DEER 2005, source engineering judgement	Total cost includes stated installation costs	Used FES calculations	8760	No hours changes
from DEER 2005, source engineering judgement	Total cost includes stated installation costs	Used FES calculations	4800	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Focus On Energy savings numbers	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Focus On Energy savings numbers	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Focus On Energy savings numbers	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	8760	No hours changes
RSMeans 2007 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	8760	No hours changes
engineering judgement	Total cost includes stated installation costs	Used Ohio TRM methodology. Updated heating and cooling hours for led analysis	8760	Hours equal to kWh/kW used instead of annual hours of use
engineering judgement	Total cost includes stated installation costs	Used Ohio TRM methodology. Updated heating and cooling hours for led analysis	8760	Hours equal to kWh/kW used instead of annual hours of use
engineering judgement	Total cost includes stated installation costs	Used Ohio TRM methodology. Updated heating and cooling hours for led analysis	8760	Hours equal to kWh/kW used instead of annual hours of use
engineering judgement	Total cost includes stated installation costs	Used Ohio TRM methodology. Updated heating and cooling hours for led analysis	8760	Hours equal to kWh/kW used instead of annual hours of use
engineering judgement	Total cost includes stated installation costs	Used Ohio TRM methodology. Updated heating and cooling hours for led analysis	8760	Hours equal to kWh/kW used instead of annual hours of use
engineering judgement	Total cost includes stated installation costs	Used Ohio TRM methodology. Updated heating and cooling hours for led analysis	8760	Hours equal to kWh/kW used instead of annual hours of use
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	4990	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	4380	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	4380	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	4380	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	5475	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	5475	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	5475	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	5840	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	4380	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	4380	No hours changes
RSMeans 2008 Costworks	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	4380	No hours changes
LECG 2008 [illegible]	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	365	Increasing building hours of use used instead of intermittent equipment hours
CEC 2006 DEER [illegible] $28	Total cost is an incremental equipment cost and does not include installation cost	Used Ohio TRM	8760	Hours revised to equal kWh/kW
CEC 2006 DEER [illegible] $28	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	8760	No hours changes
CEC 2006 DEER [illegible] $28	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	5760	No hours changes
CEC 2006	Total cost is an incremental equipment cost and does not include installation cost	Used FES calculations	5760	No hours changes
RSMeans 2007 Costworks, engineering judgement	Total cost includes stated installation costs	Used Ohio TRM	6000	No hours changes
[illegible]	Estimate based on [illegible]	Used FES calculations	5000	No hours changes
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM	6000	Hours revised to equal kWh/kW
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM	6000	Hours revised to equal kWh/kW
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM	6000	Hours revised to equal kWh/kW
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM	6000	Hours revised to equal kWh/kW
RSMeans 2007 Costworks	Total cost includes stated installation costs	Used Ohio TRM	1000	Hours revised to equal kWh/kW
Based on [illegible] engineering judgement	Total cost is an incremental equipment cost and does not include installation cost	Used FES savings as no value in TRM [illegible]	4380	No hours changes
Based on [illegible] engineering judgement	Total cost includes stated installation costs	Used TRM for cooling	1227	No hours changes
Based on [illegible] engineering judgement	Total cost includes stated installation costs	Used TRM for cooling	1904	No hours changes

North Carolina Measure Da

					Commercial
Measure Code Technolgy, File Source, Version	Proposed Technologies for Measures Library	Assumed hours of operation	CF	Actual kW	Target kWh percust
1.01.01.FESL1.v01	T8 4ft 1 lamp	3680	1.00		51.52
1.01.02.FESL1.v01	T8 4ft 2 lamp	3680	1.00		62.56
1.01.03.FESL1.v01	T8 4ft 3 lamp	3680	1.00		117.76
1.01.04.FESL1.v01	T8 4ft 4 lamp	3680	1.00		139.84
1.01.05.FESL1.v01	T8 8ft 1 lamp	3680	1.00		40.48
1.01.06.FESL1.v01	T8 8ft 2 lamp	3680	1.00		73.60
1.01.07.FESL1.v01	T8 2ft 1 lamp	3680	1.00		29.44
1.01.08.FESL1.v01	T8 2ft 2 lamp	3680	1.00		36.80
1.01.09.FESL1.v01	T8 2ft 3 lamp	3680	1.00		73.60
1.01.10.FESL1.v01	T8 2ft 4 lamp	3680	1.00		80.96
1.01.11.FESL1.v01	T8 3ft 1 lamp	3680	1.00		40.48
1.01.12.FESL1.v01	T8 3ft 2 lamp	3680	1.00		36.80
1.01.13.FESL1.v01	T8 3ft 3 lamp	3680	1.00		44.16
1.01.14.FESL1.v01	T8 3ft 4 lamp	3680	1.00		73.60
1.01.15.FESL1.v01	T8 HO 8 ft 1 Lamp	3680	1.00		92.00
1.01.16.FESL1.v01	T8 HO 8 ft 2 Lamp	3680	1.00		184.00
1.02.01.FESL1a.v01	HPT8 4ft 1 lamp, T8 to HPT8	3680	1.00		19.00
1.02.02.FESL1a.v01	HPT8 4ft 2 lamp, T8 to HPT8	3680	1.00		31.00
1.02.03.FESL1a.v01	HPT8 4ft 3 lamp, T8 to HPT8	3680	1.00		35.00
1.02.04.FESL1a.v01	HPT8 4ft 4 lamp, T8 to HPT8	3680	1.00		52.00
1.02.05.FESL1a.v01	HPT8 4ft 1 lamp, T12 to HPT8	3680	1.00		63.48
1.02.06.FESL1a.v01	HPT8 4ft 2 lamp, T12 to HPT8	3680	1.00		82.02
1.02.07.FESL1a.v01	HPT8 4ft 3 lamp, T12 to HPT8	3680	1.00		145.18
1.02.08.FESL1a.v01	HPT8 4ft 4 lamp, T12 to HPT8	3680	1.00		169.65
1.02.09.FESL1a.v01	T12 8ft 1 lamp retrofit to HPT8 T8 4ft 2 lamp	3680	1.00		67.0
1.02.10.FESL1a.v01	T12 8ft 2 lamp retrofit to HPT8 T8 4ft 4 lamp	3680	1.00		49.0
1.02.11.FESL1a.v01	T12HO 8ft 1 lamp retrofit to HPT8 T8 4ft 2 lamp	3680	1.00		174.0
1.02.12.FESL1a.v01	T12HO 8ft 2 lamp retrofit to HPT8 T8 4ft 4 lamp	3680	1.00		293.0
1.03.01.FESL1a.v01	LW HPT8 4ft 1 lamp, T8LWT8	3680	1.00		29.0
1.03.02.FESL1a.v01	LW HPT8 4ft 2 lamp, T8LWT8	3680	1.00		48.0
1.03.03.FESL1a.v01	LW HPT8 4ft 3 lamp, T8LWT8	3680	1.00		62.0
1.03.04.FESL1a.v01	LW HPT8 4ft 4 lamp	3680	1.00		92.0
1.03.05.FESL1.v01	Low Watt T8 lamps	3680	1.00		15.00
1.04.01.FESL2.v01	1 Lamp T5 with Elec Ballast replacing T12	3680	1.00		44.16
1.04.02.FESL2.v01	2 Lamp T5 replacing T12	3680	1.00		44.16

1.04.03.FESL2.v01	3 Lamp T5 replacing T12	3680	1.00		99.36
1.04.04.FESL2.v01	4 Lamp T5 replacing T12	3680	1.00		88.32
1.04.05.FESL2.v01	1 Lamp T5 HO with Elec Ballast replacing T12	3680	1.00		55.00
1.04.06.FESL2.v01	2 Lamp T5HO replacing T12	3680	1.00		70.00
1.04.07.FESL2.v01	3 Lamp T5HO replacing T12	3680	1.00		92.00
1.04.08.FESL2.v01	4 Lamp T5HO replacing T12	3680	1.00		191.00
1.05.01.FESL7.v01	Occupancy Sensors under 500 W	3680	1.00		427.00
1.05.02.FESL7.v01	Occupancy Sensors over 500 W	3680	1.00		1068.00
1.05.03.FESL10.v01	Central Lighting Control	3680	1.00		11500.00
1.05.04.FESL11.v01	Switching Controls for Multilevel Lighting	3680	1.00		8000.00
1.05.05.FESL12.v01	Daylight Sensor controls	3680	1.00		14800.00
1.06.01.FESL3.v01	High Bay 3L T5HO Replacing 250W HID	4160	1.00		449.00
1.06.02.FESL3.v01	High Bay 4LT5HO Replacing 400W HID	4160	1.00		882.00
1.06.03.FESL3.v01	High Bay 6L T5HO replacing 400W HID	4160	1.00		374.00
1.06.05.FESL3.v01	High Bay 6L T5HO Double fixture replace 1000W HID	0.035	1.00		1456.00
1.06.10.FESL3.v01	High Bay Fluorescent 3LF32T8 Replacing 150-175W HID	4160	1.00		341.00
1.06.10.FESL3.v01	High Bay Fluorescent 4LF32T8 Replacing 250W HID	4160	1.00		616.00
1.06.11.FESL3.v01	High Bay Fluorescent 6LF32T8 Replacing 400W HID	4160	1.00		961.00
1.06.12.FESL3.v01	High Bay Fluorescent 8LF32T8 Replacing 400W HID	4160	1.00		649.00
1.06.13.FESL3.v01	High Bay Fluorescent 8LF32T8 Double fixture replace 1000W HID	4160	1.00		2005.00
1.06.20.FESL3.v01	42W 8 Lamp Hi Bay CFL	4160	1.00		345.00
1.06.21.FESL3.v01	Pulse Start Metal Halide retrofit only	4160	1.00		430.00
1.07.05.FESL13.v01	Exterior HID replacement to 175W HID retrofit	3833	-	0.07	268.00
1.07.06.FESL13.v01	Exterior HID replacement above 175W to 250W HID retrofit	3833	-	0.107	409.00
1.07.07.FESL13.v01	Exterior HID replacement above 250W to 400W HID retrofit	3833	-	0.184	706.00
1.07.08.FESL15.v01	Garage HID replacement to 175W HID retrofit	8760	1.00	0.07	611.00
1.07.09.FESL15.v01	Garage HID replacement above 175W to 250W HID retrofit	8760	1.00	0.107	936.00
1.07.10.FESL15.v01	Garage HID replacement above 250W to 400W HID retrofit	8760	1.00	0.184	1614.00
1.07.11.FESL14.v01	Exterior Lighting BiLevel Control w Override, 150 to 1000 HID	3833	-	0.194	743.00
1.07.12.FESL18.v01	Sports Field Lighting HiLo Control	1000	-	0.531	531.00
1.08.01.FESL6.v01	CFL Fixture	3680	1.00		294.40
1.08.02.FESL6.v01	CFL Screw in	3680	1.00		147.20
1.09.01.FESL5.v01	LED Exit Signs Electronic Fixtures (Retrofit Only)	8760	1.00		158.00
1.10.01.FESL8.v01	LED Auto Traffic Signals	3235	1.00		275.00
1.10.02.FESL8.v01	LED Pedestrian Signals	3409	1.00		150.00
1.11.01.FESL9.v01	Light Tube	3680	1.00		361.00
3.01.01.FESH2.v01	HP Water Heater 10 to 50 MBH	5037	1.00		21156.00
3.01.02.FESH2.v01	HP Water Heater 50 to 100 MBH	5037	1.00		52890.00
3.01.03.FESH2.v01	HP Water Heater 100 to 300 MBH	5037	1.00		141041.00
3.01.04.FESH2.v01	HP Water Heater 300 to 500 MBH	5037	1.00		282081.00
3.01.05.FESH2.v01	HP Water Heater above 500 MBH	5037	1.00		423122.00
4.01.01.FESM1.v01	Motors 1 to 5 HP	3680	1.00		113.30
4.01.02.FESM1.v01	Motors 7.5 to 20 HP	3680	1.00		408.43

4.01.03.FESM1.v01	Motors 25 to 100 HP	3680	1.00		1056.04
4.01.04.FESM1.v01	Motors 125 to 250 HP	3680	1.00		2435.36
4.02.01.FESM3.v01	Pumps HP 1.5	3680	1.00		353.28
4.02.02.FESM3.v01	Pumps HP 2	3680	1.00		471.04
4.02.03.FESM3.v01	Pumps HP 3	3680	1.00		706.56
4.02.04.FESM3.v01	Pumps HP 5	3680	1.00		1177.60
4.02.05.FESM3.v01	Pumps HP 7.5	3680	1.00		1766.40
4.02.06.FESM3.v01	Pumps HP 10	3680	1.00		2355.20
4.02.07.FESM3.v01	Pumps HP 15	3680	1.00		3532.80
4.02.08.FESM3.v01	Pumps HP 20	3680	1.00		4710.40
4.04.01.FESM2.v01	VFD HP 1.5 Process Pumping	3713	0.78	0.44	1623.44
4.04.02.FESM2.v01	VFD HP 2 Process Pumping	3713	0.78	0.58	2164.59
4.04.03.FESM2.v01	VFD HP 3 Process Pumping	3713	0.78	0.87	3246.19
4.04.04.FESM2.v01	VFD HP 5 Process Pumping	3713	0.78	1.46	5356.69
4.04.05.FESM2.v01	VFD HP 7.5 Process Pumping	3713	0.78	2.19	8116.16
4.04.06.FESM2.v01	VFD HP 10 Process Pumping	3713	0.78	2.91	10713.39
4.04.07.FESM2.v01	VFD HP 15 Process Pumping	3713	0.78	4.37	16232.32
4.04.08.FESM2.v01	VFD HP 20 Process Pumping	3713	0.78	5.83	21643.09
4.04.09.FESM2.v01	VFD HP 25 Process Pumping	3713	0.78	7.29	27053.87
4.04.10.FESM2.v01	VFD HP 30 Process Pumping	3713	0.78	8.74	32464.64
4.04.11.FESM2.v01	VFD HP 40 Process Pumping	3713	0.78	11.66	43286.19
4.04.12.FESM2.v01	VFD HP 50 Process Pumping	3713	0.78	14.57	54108.43
5.01.01.FESC1.v01	Commercial Clothes Washers electric water heater	713	1.00		86.00
5.01.02.FESC1.v01	Commercial Clothes Washers gas water heater	713	1.00		9.00
5.02.01.FESC2.v01	Plug Load Occupancy Sensors Document Stations	2600	1.00		803.00
5.03.01.FESC3.v01	Vending Equipment Controller	3810	1.00		800.00
5.04.01.FESG6.v01	ENERGY STAR Commercial Solid Door Refrigerators less than 20ft3	8760	1.00		905.0
5.04.02.FESG6.v01	ENERGY STAR Commercial Solid Door Refrigerators 20 to 48 ft3	8760	1.00		1069.0
5.04.03.FESG6.v01	ENERGY STAR Commercial Solid Door Refrigerators more than 48ft3	8760	1.00		1361.0
5.04.04.FESG6.v01	ENERGY STAR Commercial Solid Door Freezers less than 20ft3	8760	1.00		520.0
5.04.05.FESG6.v01	ENERGY STAR Commercial Solid Door Freezers 20 to 48 ft3	8760	1.00		507.0
5.04.06.FESG6.v01	ENERGY STAR Commercial Solid Door Freezers more than 48ft3	8760	1.00		483.0
5.04.07.FESG7.v01	Energy Efficient Ice Machines less than 500 lbs	8760	1.00		1652.0
5.04.08.FESG7.v01	Energy Efficient Ice Machines 500 to 1000 lbs	8760	1.00		2695.0
5.04.09.FESG7.v01	Energy Efficient Ice Machines more than 1000 lbs	8760	1.00		6048.0
6.01.01.FESF1.v01	ENERGY STAR Steam Cookers 3 Pan	4380	1.00		11188.00
6.01.02.FESF1.v01	ENERGY STAR Steam Cookers 4 Pan	4380	1.00		12159.00
6.01.03.FESF1.v01	ENERGY STAR Steam Cookers 5 Pan	4380	1.00		13139.00
6.01.04.FESF1.v01	ENERGY STAR Steam Cookers 6 Pan	4380	1.00		15170.00
6.02.01.FESF2.v01	ENERGY STAR Hot Holding Cabinets Half Size	5475	1.00		1788.00
6.02.02.FESF2.v01	ENERGY STAR Hot Holding Cabinets Three Quarter Size	5475	1.00		2832.00
6.02.03.FESF2.v01	ENERGY STAR Hot Holding Cabinets Full Size	5475	1.00		5278.00
6.03.01.FESF3.v01	ENERGY STAR Fryers	4380	1.00		983.00

6.04.01.FESF4.v01	Griddles	4380	1.00		1637.00
6.05.01.FESF5.v01	Convection Ovens	4380	1.00		2262.00
6.06.01.FESF6.v01	Combination Ovens	4380	1.00		18432.00
7.01.01.FESG2.v01	Anti Sweat Heater Controls	4380	-	4.8	1489.00
7.02.01.FESG4.v01	Night covers for displays	3500	-	0.03	105.00
7.03.01.FESG3.v01	Efficient Refrigeration Condensor	4380	1.00	0.118	120.00
7.04.01.FESG5.v01	Head Pressure Control	8760	-	0.144	1264.00
8.01.01.FESI1.v01	Engineered Nozzles Compressed Air	2000	1.00		7343.00
8.02.01.FESI1.v01	Barrel Wraps Inj Mold and Extruders	5000	1.00		50.00
8.03.01.FESI3.v01	Pellet Dryer Tanks and Ducts 3 dia	4000	1.00		98.00
8.03.02.FESI3.v01	Pellet Dryer Tanks and Ducts 4 dia	4000	1.00		134.00
8.03.03.FESI3.v01	Pellet Dryer Tanks and Ducts 5 dia	4000	1.00		175.00
8.03.04.FESI3.v01	Pellet Dryer Tanks and Ducts 6 dia	4000	1.00		216.00
8.03.05.FESI3.v01	Pellet Dryer Tanks and Ducts 8 dia	4000	1.00		304.00
	Renewalbes Commercial PV per kW				1312.00

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Measures

Target kW percust	Measure life	Incremental Costs YR1	Incentive	Size Basis	Avg Size	units	Custom Notes	Code	Notes
0.014	10	$33.00	$3.00	fixture				FES-L1	
0.017	10	$36.00	$4.00	fixture				FES-L1	
0.032	10	$54.00	$9.00	fixture				FES-L1	
0.038	10	$57.00	$11.00	fixture				FES-L1	
0.011	10	$50.00	$5.00	fixture				FES-L1	
0.020	10	$54.00	$7.00	fixture				FES-L1	
0.008	10	$33.00	$3.00	fixture				FES-L1	
0.010	10	$36.00	$4.00	fixture				FES-L1	
0.020	10	$54.00	$4.20	fixture				FES-L1	
0.022	10	$57.00	$6.00	fixture				FES-L1	
0.011	10	$33.00	$3.00	fixture				FES-L1	
0.010	10	$36.00	$4.00	fixture				FES-L1	
0.012	10	$54.00	$6.50	fixture				FES-L1	
0.020	10	$57.00	$10.00	fixture				FES-L1	
0.025	10	$66.00	$10.00	fixture				FES-L1	
0.050	10	$72.00	$14.00	fixture				FES-L1	
0.005	10	$38.00	$4.00	fixture				FES-L1a	Replacing standard T8 4ft 1 lamp
0.008	10	$41.00	$6.00	fixture				FES-L1a	Replacing standard T8 4ft 2 lamp
0.009	10	$62.00	$10.00	fixture				FES-L1a	Replacing standard T8 4ft 3 lamp
0.014	10	$66.00	$12.00	fixture				FES-L1a	Replacing standard T8 4ft 4 lamp
0.017	10	$38.00	$6.00	fixture				FES-L1a	Replacing magnetic 34W T12 4ft 1 lamp
0.022	10	$41.00	$8.00	fixture				FES-L1a	Replacing magnetic 34W T12 4ft 2 lamp
0.039	10	$62.00	$12.00	fixture				FES-L1a	Replacing magnetic 34W T12 4ft 3 lamp
0.046	10	$66.00	$16.00	fixture				FES-L1a	Replacing magnetic 34W T12 4ft 4 lamp
0.018	10	$41.00	$10.00	fixture				FES-L1a	
0.013	10	$66.00	$15.00	fixture				FES-L1a	
0.047	10	$41.00	$20.00	fixture				FES-L1a	
0.080	10	$66.00	$25.00	fixture				FES-L1a	
0.008	10	$37.00	$4.00	fixture				FES-L1a	Replacing standard T8 4ft 1 lamp
0.013	10	$39.00	$6.00	fixture				FES-L1a	Replacing standard T8 4ft 2 lamp
0.017	10	$58.00	$10.00	fixture				FES-L1a	Replacing standard T8 4ft 3 lamp
0.025	10	$60.00	$12.00	fixture				FES-L1a	Replacing standard T8 4ft 4 lamp
0.004	5	$2.00	$0.50	lamp				FES-L4	
0.012	10	$59.30	$5.00	fixture				FES-L2	
0.012	10	$74.12	$8.00	fixture				FES-L2	

0.027	10	$78.60	$10.00	fixture				FES-L2	
0.024	10	$87.56	$12.00	fixture				FES-L2	
0.015	10	$120.00	$6.00	fixture				FES-L2	
0.019	10	$140.00	$9.00	fixture				FES-L2	
0.025	10	$175.00	$11.00	fixture				FES-L2	
0.052	10	$225.00	$13.00	fixture				FES-L2	
0.120	12	$200.00	$20.00	unit				FES-L7	
0.290	12	$100.00	$40.00	unit				FES-L7	
3.120	12	$2,700.00	$400.00	10,000 SF			Recomme	FES-L10	
2.440	12	$3,000.00	$400.00	10,000 SF			Recomme	FES-L11	
4.020	12	$3,000.00	$600.00	10,000 SF				FES-L12	
0.108	10	$180.00	$40.00	fixture				FES-L3	
0.210	10	$192.00	$50.00	fixture				FES-L3	
0.090	10	$350.00	$40.00	fixture				FES-L3	
0.350	10	$700.00	$120.00	fixture				FES-L3	
0.082	10	$150.00	$30.00	fixture				FES-L3	
0.148	10	$160.00	$40.00	fixture				FES-L3	
0.231	10	$160.00	$50.00	fixture				FES-L3	
0.156	10	$200.00	$40.00	fixture				FES-L3	
0.482	10	$400.00	$120.00	fixture				FES-L3	
0.083	10	$395.00	$50.00	fixture				FES-L3	
0.120	7	$150.00	$25.00	fixture				FES-L3	
0.000	12	$400.00	$40.00	fixture				FES-L13	
0.000	12	$500.00	$50.00	fixture				FES-L13	
0.000	12	$800.00	$60.00	fixture				FES-L13	
0.070	12	$400.00	$40.00	fixture				FES-L15	
0.107	12	$500.00	$50.00	fixture				FES-L15	
0.184	12	$800.00	$60.00	fixture				FES-L15	
0.000	10	$300.00	$45.00	fixture				FES-L15	
0.000	10	$400.00	$50.00	fixture				FES-L15	
0.080	12	$45.00	$10.00	fixture				FES-L6	
0.040	2	$3.00	$2.00	lamp				FES-L6	
0.018	15	$25.00	$10.00	fixture				FES-L5	
0.085	6	$50.00	$12.50	lamp				FES-L8	
0.044	8	$100.00	$25.00	lamp				FES-L8	
0.100	14	$500.00	$75.00	unit				FES-L9	
4.200	15	$4,000.00	$2,000.00	unit	30,000	Btuh	Recomme	FES-H2	
10.500	15	$7,000.00	$3,500.00	unit	75,000	Btuh	Recomme	FES-H2	
28.000	15	$10,000.00	$5,000.00	unit	200,000	Btuh	Recomme	FES-H2	
56.000	15	$14,000.00	$7,000.00	unit	400,000	Btuh	Recomme	FES-H2	
84.000	15	$18,000.00	$9,000.00	unit	600,000	Btuh	Recomme	FES-H2	
0.031	15	$88	$25.00	per motor	2.5	hp		FES-M1	
0.111	15	$227	$105.00	per motor	13.1	hp		FES-M1	

0.287	15	$558	$271.43	per motor	54.3	hp		FES-M1	
0.662	15	$1,079	$725.00	per motor	181.3	hp		FES-M1	
0.096	15	$350.00	$210.00	unit				FES-M3	
0.128	15	$350.00	$220.00	unit				FES-M3	
0.192	15	$350.00	$230.00	unit				FES-M3	
0.320	15	$341.00	$240.00	unit				FES-M3	
0.480	15	$498.00	$250.00	unit				FES-M3	
0.640	15	$332.00	$260.00	unit				FES-M3	
0.960	15	$585.00	$300.00	unit				FES-M3	
1.280	15	$850.00	$400.00	unit				FES-M3	
0.343	15	$1,445.00	$60.00	unit				FES-M2	
0.457	15	$1,645.00	$80.00	unit				FES-M2	
0.686	15	$1,845.00	$120.00	unit				FES-M2	
1.143	15	$2,070.00	$200.00	unit				FES-M2	
1.714	15	$2,860.00	$300.00	unit				FES-M2	
2.286	15	$2,860.00	$400.00	unit				FES-M2	
3.429	15	$3,265.00	$600.00	unit				FES-M2	
4.571	15	$4,515.00	$800.00	unit				FES-M2	
5.714	15	$5,120.00	$1,000.00	unit				FES-M2	
6.857	15	$5,770.00	$1,200.00	unit				FES-M2	
9.143	15	$8,095.00	$1,600.00	unit				FES-M2	
11.429	15	$8,950.00	$2,000.00	unit				FES-M2	
0.120	10	$240.00	$50.00	unit				FES-C1	
0.030	10	$240.00	$50.00	unit				FES-C1	
0.055	5	$150.00	$25.00	unit				FES-C2	
0.210	5	$160.00	$50.00	unit				FES-C3	
0.103	12	$250.00	$70.00	per unit	12	ft^3		FES-G6	
0.122	12	$500.00	$70.00	per unit	30	ft^3		FES-G6	
0.155	12	$900.00	$70.00	per unit	62	ft^3		FES-G6	
0.059	12	$150.00	$70.00	per unit	12	ft^3		FES-G6	
0.058	12	$400.00	$70.00	per unit	30	ft^3		FES-G6	
0.055	12	$700.00	$70.00	per unit	63	ft^3		FES-G6	
0.189	12	$600.00	$150.00	per unit	315	lb/24 hrs		FES-G7	
0.308	12	$1,500.00	$250.00	per unit	704	lb/24 hrs		FES-G7	
0.690	12	$2,000.00	$500.00	per unit	1454	lb/24 hrs		FES-G7	
2.550	12	$4,150.00	$300.00	unit				FES-F1	
2.850	12	$4,150.00	$400.00	unit				FES-F1	
3.160	12	$4,150.00	$500.00	unit				FES-F1	
3.460	12	$4,150.00	$600.00	unit				FES-F1	
0.330	12	$1,783.00	$200.00	unit				FES-F2	
0.520	12	$1,783.00	$300.00	unit				FES-F2	
0.960	12	$1,783.00	$400.00	unit				FES-F2	
0.200	12	$4,708.00	$150.00	unit				FES-F3	

0.400	12	$3,604.00	$200.00	unit				FES-F4	
0.500	12	$2,713.00	$200.00	unit				FES-F5	
4.200	12	$16,884.00	$1,000.00	unit				FES-F6	
0.000	15	$250.00	$40.00	per door				FES-G2	
0.000	15	$35.00	$10.00	per lineal foot				FES-G4	
0.118	15	$35.00	$12.00	per ton			Recomme	FES-G3	
0.000	15	$80.00	$60.00	per ton			Recomme	FES-G5	
3.680	15	$80.00	$20.00	unit				FES-I1	
0.010	5	$2.00	$1.00	machine tonnage				FES-I2	
0.020	5	$32.69	$15.00	LF				FES-I3	
0.030	5	$43.31	$20.00	LF				FES-I3	
0.040	5	$53.97	$25.00	LF				FES-I3	
0.050	5	$64.69	$30.00	LF				FES-I3	
0.080	5	$86.46	$40.00	LF				FES-I3	
0.470	20	$8,000.00	$2,500.00	per kW				FES-R1B	

Ohio HEHC

	net	
	kw	kwh
window film	0.002	3.393452
15W CFL	0.002382	28.83274
13W bulb	0.004382	53.04013
difference between old/new kit	0.004382	73.85408
Old HEHC Savings	0.13125	352.7
New HEHC Savings	0.135632	426.5541
Plus 6 pack of CFLs	0.189992	794.5713
*removing 15W and adding 2 13W	keep 2x13 W and 1x20W	
20W bulb net savings from TMW report	0.002023	23.35298
HEHC Savings for CFLs	0.065147	497.4504
HEHC Savings for Kit	0.124845	297.1208
Total savings +69	0.189992	863.5713

# used for kit bulbs			
15W	28.83274 bulb removed		
20W	23.35		
TMW report pg 5 gross 1 yr savings			
15W	64.17976 bulb removed		
20W	51.98214		
TMW report pg 5 net 1 year savings			
15W	28.83274 bulb removed		
20W	23.35298		
FR (diff bet net and gross)			
15W	0.55075		28.83276
20W	0.55075		23.35298

Final HEHC and PER Results_MTO.xls

		OH	KY
Total Net Sa	kWh	**387**	**264**
	kW	**0.07**	**0.03**
	Therm	**31**	**20**
Measure Life		8.0	8.2

		204	Free Riders				kW/kWh Ratios		
PER	Bill Savings	Kit Savings	Kit	Recs		Net Savings	Kit	Other	Net kW
KWH	636	204	30.60%	49.0%		362	0.000112	0.000417	0.11
Therm	35	11	30.60%	49.0%		20			
HEHC									
Ohio									
kWh	468	204	30.60%	7.1%		387	0.000112	0.000233	0.07
Therm	36	11	30.60%	7.1%		31			
KY									
kWh	343	204	26.00%	18.8%		264	0.000112	0.000151	0.03
Therm	25	11	26.00%	18.8%		20			

*****Therm kit savings based on 2007 PER report***

Net Savings	kWh	kW	Therm	Measure Life
OH PER	362	0.11	20	same as before
OH HEHC	387	0.07	31	8.0
KY HEHC	264	0.03	20	8.2

Ohio HEHC

	net	
	kw	kwh
window film	0.002	3.393452
15W CFL	0.002382	28.83274
13W bulb	0.004382	53.04013
difference between old/new kit	0.004382	73.85408
Original HEHC Savings	0.13125	352.7
New HEHC Savings	0.135632	426.5541
Plus 6 pack of CFLs (52.76*6*(1-0.1576%))	0.435895	695.0603
*removing 15W and adding 2 13W	keep 2x13 W and 1x20W	
20W bulb net savings from TMW report	0.002023	23.35298
HEHC Savings for CFLs	0.31105	397.9394
HEHC Savings for Kit	0.124845	297.1208
Total savings +69	0.435895	764.0603

# used for kit bulbs			
15W	28.83274	bulb removed	
20W	23.35		
TMW report pg 5 gross 1 yr savings			
15W	64.17976	bulb removed	
20W	51.98214		
TMW report pg 5 net 1 year savings			
15W	28.83274	bulb removed	
20W	23.35298		
FR (diff bet net and gross)			
15W	0.55075		28.83276
20W	0.55075		23.35298

Final HEHC and PER Results_MTO.xls

		OH	KY
Total Net Sa\	kWh	**387**	**264**
	kW	**0.07**	**0.03**
	Therm	**31**	**20**
Measure Life		**8.0**	**8.2**

		204 Free Riders					kW/kWh Ratios		
PER	Bill Savings	Kit Savings	Kit	Recs	**Net Savings**		Kit	Other	**Net kW**
KWH	636	204	30.60%	49.0%	**362**		0.000112	0.000417	**0.11**
Therm	35	11	30.60%	49.0%	**20**				
HEHC									
Ohio									
kWh	468	204	30.60%	7.1%	**387**		0.000112	0.000233	**0.07**
Therm	36	11	30.60%	7.1%	**31**				
KY									
kWh	343	204	26.00%	18.8%	**264**		0.000112	0.000151	**0.03**
Therm	25	11	26.00%	18.8%	**20**				

***Therm kit savings based on 2007 PER report*

Net Savings	kWh	kW	Therm	Measure Life
OH PER	362	0.11	20	same as before
OH HEHC	387	0.07	31	8.0
KY HEHC	264	0.03	20	8.2

Total kW			13-watt CFL	Showerhead	Bathroom aerator	Kitchen aerator	Outlet gaskets	20W CFL	6 pack cfl
			5	10	10	10	20	5	5
	kW Impact	Levelized A	3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	0.05
Year 1	11.662	5.411	3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	0.05
Year 2	11.662	5.411	3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	0.05
Year 3	11.662	5.411	3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	0.05
Year 4	11.662	5.411	3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	0.05
Year 5	11.662	5.411	3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	0.05
Year 6	6.403	5.411		4.548041	0.03587	0.028583	1.790032		
Year 7	6.403	5.411		4.548041	0.03587	0.028583	1.790032		
Year 8	6.403	5.411		4.548041	0.03587	0.028583	1.790032		
Year 9	6.403	5.411		4.548041	0.03587	0.028583	1.790032		
Year 10	6.403	5.411		4.548041	0.03587	0.028583	1.790032		
Year 11	1.790	5.411					1.790032		
Year 12	1.790	5.411					1.790032		
Year 13	1.790	5.411					1.790032		
Year 14	1.790	5.411					1.790032		
Year 15	1.790	5.411					1.790032		
Year 16	1.790	5.411					1.790032		
Year 17	1.790	5.411					1.790032		
Year 18	1.790	5.411					1.790032		
Year 19	1.790	5.411					1.790032		
Year 20	1.790	5.411					1.790032		
	5.411								

	Avg		
for 1000 kits	kW	kWh	Therm
CFL (13W)	3.311458	72532.98	-72.5029
Showerhead	4.548041	41493.94	2795.821
Bath Aerator	0.03587	2662.319	101.3196
Kitchen Aerator	0.028583	2323.417	101.0748
Outlet Gaskets	1.790032	6139.082	82.88402
CFL (20W)	1.947917	42666.46	-42.6488
6 pack cfl	25	184000	

OHIO Impacts	
kw	5.411
kw per kit	0.005411
kwh	58,179
kwh per kit	58.17878
therm	1,553
therm per kit	1.553204

3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	25
3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	25
3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	25
3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	25
3.311458	4.548041	0.03587	0.028583	1.790032	1.947917	25
0	4.548041	0.03587	0.028583	1.790032	0	0
0	4.548041	0.03587	0.028583	1.790032	0	0
0	4.548041	0.03587	0.028583	1.790032	0	0
0	4.548041	0.03587	0.028583	1.790032	0	0
0	4.548041	0.03587	0.028583	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0
0	0	0	0	1.790032	0	0

KW SAVINGS - EUL - KIT ONLY W/ CFLS

13-watt CFL	Showerhead	Bathroom aerator	Kitchen aerator	Outlet gaskets	20W CFL	~~6 pack cfl~~
3.311458333	4.54804104	0.0358696	0.0285833	1.79003165	1.947916667	25
3.311458333	4.54804104	0.0358696	0.0285833	1.79003165	1.947916667	25
3.311458333	4.54804104	0.0358696	0.0285833	1.79003165	1.947916667	25
3.311458333	4.54804104	0.0358696	0.0285833	1.79003165	1.947916667	25
3.31	24.02	0.19	0.15	19.88	1.95	~~25.00~~
14.95	36.31	0.29	0.23	22.73	8.79	~~112.83~~
3.49	8.48	0.07	0.05	5.31	2.05	~~26.35~~

19.45 kW
0.02 kW/kit

with NPV and balloon payments

Total kWh			13-watt CFL	Showerhead	Bathroom aerator	Kitchen aerator	Outlet gaskets	20W CFL	6 pack cfl
			5	10	10	10	20	5	5
	kWh Savings	Levelized L	72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	368
Year 1	167,818	58,179	72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	368
Year 2	167,818	58,179	72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	368
Year 3	167,818	58,179	72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	368
Year 4	167,818	58,179	72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	368
Year 5	167,818	58,179	72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	368
Year 6	52,619	58,179		41493.94	2662.319	2323.417	6139.082		
Year 7	52,619	58,179		41493.94	2662.319	2323.417	6139.082		
Year 8	52,619	58,179		41493.94	2662.319	2323.417	6139.082		
Year 9	52,619	58,179		41493.94	2662.319	2323.417	6139.082		
Year 10	52,619	58,179		41493.94	2662.319	2323.417	6139.082		
Year 11	6,139	58,179					6139.082		
Year 12	6,139	58,179					6139.082		
Year 13	6,139	58,179					6139.082		
Year 14	6,139	58,179					6139.082		
Year 15	6,139	58,179					6139.082		
Year 16	6,139	58,179					6139.082		
Year 17	6,139	58,179					6139.082		
Year 18	6,139	58,179					6139.082		
Year 19	6,139	58,179					6139.082		
Year 20	6,139	58,179					6139.082		
Total	1,163,576								
	58,179								

OHIO Impacts	
kw	19.452
kw per kit	0.02
kwh	226,281
kwh per kit	226.28
therm	5,714
therm per kit	5.71

72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	184000
72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	184000
72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	184000
72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	184000
72532.98	41493.94	2662.319	2323.417	6139.082	42666.46	184000
0	41493.94	2662.319	2323.417	6139.082	0	0
0	41493.94	2662.319	2323.417	6139.082	0	0
0	41493.94	2662.319	2323.417	6139.082	0	0
0	41493.94	2662.319	2323.417	6139.082	0	0
0	41493.94	2662.319	2323.417	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0
0	0	0	0	6139.082	0	0

KWH SAVINGS - EUL - KIT ONLY W/ CFLS

13-watt CFL	Showerhead	Bathroom aerator	Kitchen aerator	Outlet gaskets	20W CFL	~~6 pack cfl~~
72532.97917	41493.9366	2662.3188	2323.4167	6139.08228	42666.45833	~~184000~~
72532.97917	41493.9366	2662.3188	2323.4167	6139.08228	42666.45833	~~184000~~
72532.97917	41493.9366	2662.3188	2323.4167	6139.08228	42666.45833	~~184000~~
72532.97917	41493.9366	2662.3188	2323.4167	6139.08228	42666.45833	~~184000~~
72,532.98	219,171.80	14,062.42	12,272.33	68,172.20	42,666.46	~~184000~~
327,359.41	331,242.10	21,253.04	18,547.61	77,971.88	192,564.36	~~830,437.84~~
76,449.76	77,356.50	4,963.32	4,331.51	18,209.09	44,970.45	~~193,936.00~~

226,280.83 kWh
226.28 kWh/kit

Total Therms			13-watt CFL	Showerhead	Bathroom aerator	Kitchen aerator	Outlet gaskets	20W CFL
			5	10	10	10	20	5
	Therm Savings	Levelized L	-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
Year 1	2,966	1,553	-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
Year 2	2,966	1,553	-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
Year 3	2,966	1,553	-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
Year 4	2,966	1,553	-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
Year 5	2,966	1,553	-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
Year 6	3,081	1,553		2795.821	101.3196	101.0748	82.88402	
Year 7	3,081	1,553		2795.821	101.3196	101.0748	82.88402	
Year 8	3,081	1,553		2795.821	101.3196	101.0748	82.88402	
Year 9	3,081	1,553		2795.821	101.3196	101.0748	82.88402	
Year 10	3,081	1,553		2795.821	101.3196	101.0748	82.88402	
Year 11	83	1,553					82.88402	
Year 12	83	1,553					82.88402	
Year 13	83	1,553					82.88402	
Year 14	83	1,553					82.88402	
Year 15	83	1,553					82.88402	
Year 16	83	1,553					82.88402	
Year 17	83	1,553					82.88402	
Year 18	83	1,553					82.88402	
Year 19	83	1,553					82.88402	
Year 20	83	1,553					82.88402	
Total	31,064							
	1,553							

-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
-72.5029	2795.821	101.3196	101.0748	82.88402	-42.6488
0	2795.821	101.3196	101.0748	82.88402	0
0	2795.821	101.3196	101.0748	82.88402	0
0	2795.821	101.3196	101.0748	82.88402	0
0	2795.821	101.3196	101.0748	82.88402	0
0	2795.821	101.3196	101.0748	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0
0	0	0	0	82.88402	0

THERM SAVINGS - EUL - KIT ONLY W/ CFLS

13-watt CFL	Showerhead	Bathroom aerator	Kitchen aerator	Outlet gaskets	20W CFL	~~6 pack cfl~~
-72.502875	2795.8209	101.31957	101.07475	82.884019	-42.64875	
-72.502875	2795.8209	101.31957	101.07475	82.884019	-42.64875	
-72.502875	2795.8209	101.31957	101.07475	82.884019	-42.64875	
-72.502875	2795.8209	101.31957	101.07475	82.884019	-42.64875	
-72.50	14767.58	535.17	533.88	920.40	-42.65	
-327.22	22318.77	808.82	806.87	1052.70	-192.48	
-76.42	5212.21	188.89	188.43	245.84	-44.95	

5714.00 therm
5.71 therm/kit

Home Performance with ENERGY STAR
Duke Energy **Ohio**

Assumption

Free Ridership	0%	Zero free ridership assumed because there is no program like this in existence in the marketplace
kWh Savings	4000	All Electric Home, 45 year old home, 16 year old heat pump, Enercom Calculator, average insulation
	2000	Gas Heated Home, 45 year old home, 16 year old heat pump, Enercom Calculator, average insulation
Measure Life	15 Years	Average Life of heating and cooling equipment
Load Shape	orte50_3	All Electric Home
	ortg50_3	Gas Heated Home

Measures Included in Program

Improvement	Requirement	Report Name
Insulation	US DOE recommendation or higher for that area	Insulation
Infiltration	< 250 cfm	Caulking and Sealing
AC	Seer 14 or better	AC
Gas Furnace	90 AFUE or better	Furnace - Gas
Heat Pump	Any	Heat Pump

	Revised Estimate with uniform op hr.				CURRENT SAW IMP/		7daysx12m		DIFFERENCE (Revised-SAW)			
SAW Measure Name	kWh/meas	kW/measu	avg hours		kWh/measure	kW/measu	avg hours/	4.33*12*7				
NOT IN SAW ?	587	0.093	5,197				avg hours/	hours	kW/measu	kWh/meas	hours	avg hours/c
NOT IN SAW:CUSTOM												
Compact Fluorescent Fixture	401	0.077	4,397	[illegible]	294.00	0.08	10.00	3637.20	(0.00)	106.55	669.80	4.23
Compact Fluorescent Screw in	170	0.037	3,773	[illegible]	147.00	0.04	10.00	3637.20	(0.00)	22.79	135.80	2.67
LED Auto Traffic Signals	275	0.085		[illegible]	275.00	0.09	9.00	3273.48	0.00	0.00	(3273.48)	(0.10)
LED Exit Signs Electronic Fixtures (Retrofit Only)	158	0.018	8,760	[illegible]	158.00	0.02	24.00	8729.28	0.00	0.00	30.72	0.13
LED Pedestrian Signals	150	0.044		[illegible]	150.00	0.04	9.00	3273.48	0.00	0.00	(3273.48)	0.37
Occupancy Sensors over 500 Watts	994	0.270		[illegible]	1068.00	0.29	10.00	3637.20	(0.02)	(74.00)	(3637.20)	0.12
Occupancy Sensors under 500 Watts	397	0.110		[illegible]	427.00	0.12	10.00	3637.20	(0.01)	(30.00)	(3637.20)	(0.08)
NOT IN SAW:CUSTOM												
T-5 1 Lamp with Electronic Ballast (replacing T-1	48	0.005	4,028	[illegible]	44.00	0.01	10.00	3637.20	(0.01)	4.34	390.80	16.37
T-5 4 Lamp with Electronic Ballast (replacing T-1	97	0.020	4,028	[illegible]	88.00	0.02	10.00	3637.20	(0.00)	8.67	390.80	3.51
T-5 High Output 2 Lamp with Electronic Ballast (	77	0.018	4,028	[illegible]	70.00	0.02	10.00	3637.20	(0.00)	6.53	390.80	2.01
T-5 High Output 4 Lamp with Electronic Ballast (	85	0.017	4,028	[illegible]	216.00	0.05	11.00	4000.92	(0.03)	(131.41)	27.08	2.51
High Bay 2L T-5 High Output	1,042	0.158	5,197	[illegible]	458.00	0.10	13.00	4728.36	0.06	584.08	468.64	5.19
High Bay 4L T-5 High Output	1,311	0.198	5,197	[illegible]	882.00	0.21	12.00	4364.64	(0.01)	429.10	832.36	6.23
High Bay 6L T-5 High Output	557	0.083	5,197	[illegible]	374.00	0.09	11.00	4000.92	(0.01)	182.60	1196.08	7.39
High Bay 8L T-5 High Output	[redacted]		5,197	[illegible]	2620.00	0.53	14.00	5092.08	(0.56)	(2781.11)	104.92	2.63
High Bay Fluorescent 4 Lamp (F32 Watt T8)	915	0.140	5,197	[illegible]	616.00	0.15	11.00	4000.92	(0.01)	299.30	1196.08	6.94
High Bay Fluorescent 6 Lamp (F32 Watt T8)	1,429	0.221	5,197	[illegible]	961.00	0.23	11.00	4000.92	(0.01)	467.60	1196.08	6.76
High Bay Fluorescent 8 Lamp (F32 Watt T8)	965	0.146	5,197	[illegible]	649.00	0.16	11.00	4000.92	(0.01)	315.77	1196.08	7.19
T-8 High Output 8 ft 2 Lamp	201	0.041	4,028	[illegible]	184.00	0.05	10.00	3637.20	(0.01)	17.40	390.80	3.51
T-8 2ft 1 lamp	30	0.006	4,028	[illegible]	29.44	0.01	10.00	3637.20	(0.00)	0.77	390.80	3.51
T-8 2ft 2 lamp	38	0.007	4,028	[illegible]	36.80	0.01	10.00	3637.20	(0.00)	1.47	390.80	5.78
T-8 2ft 3 lamp	81	0.016	4,028	[illegible]	73.60	0.02	10.00	3637.20	(0.00)	6.96	390.80	3.51
T-8 2ft 4 lamp	89	0.018	4,028	[illegible]	80.96	0.02	10.00	3637.20	(0.00)	7.66	390.80	3.51
T-8 3ft 1 lamp	44	0.009	4,028	[illegible]	40.48	0.01	10.00	3637.20	(0.00)	3.83	390.80	3.51
T-8 3ft 2 lamp	40	0.008	4,028	[illegible]	36.80	0.01	10.00	3637.20	(0.00)	3.48	390.80	3.51
T-8 3ft 3 lamp	48	0.010	4,028	[illegible]	44.16	0.01	10.00	3637.20	(0.00)	4.18	390.80	3.51
T-8 4ft 1 lamp	56	0.011	4,028	[illegible]	51.52	0.01	10.00	3637.20	(0.00)	4.87	390.80	3.51
T-8 4ft 2 lamp	68	0.014	4,028	[illegible]	62.56	0.02	10.00	3637.20	(0.00)	5.92	390.80	3.56
T-8 4ft 3 lamp	129	0.025	4,028	[illegible]	117.76	0.03	10.00	3637.20	(0.01)	11.14	390.80	4.13
T-8 4ft 4 lamp	153	0.031	4,028	[illegible]	139.84	0.04	10.00	3637.20	(0.01)	13.22	390.80	3.49
T-8 8ft 1 lamp	44	0.009	4,028	[illegible]	40.48	0.01	10.00	3637.20	(0.00)	3.83	390.80	3.51
T-8 8ft 2 lamp	81	0.016	4,028	[illegible]	73.60	0.02	10.00	3637.20	(0.00)	6.96	390.80	3.66

Table 1

Measure	Covington			for 3 ton unit		
	kWh/ton	kW/ton	Therm/ton	kWh	kW	therm
Gas_seer14	277	0.076	75	832	0.229	225
Gas_seer15	352	0.110	72	1057	0.331	217
Gas_seer16	505	0.210	66	1515	0.630	198
Gas_seer17	558	0.226	66	1673	0.677	197
Hp_seer14	779	0.090	0	2337	0.270	0
Hp_seer15	789	0.156	0	2366	0.469	0
Hp_seer16	1175	0.275	0	3524	0.825	0
Hp_seer17	1240	0.223	0	3721	0.669	0
Hp_seer18	1293	0.280	0	3879	0.839	0
Dfhp_seer14	378	0.090	37	1135	0.270	111
Dfhp_seer15	605	0.156	28	1815	0.469	85
Dfhp_seer16	927	0.275	31	2780	0.825	92
Dfhp_seer17	1012	0.223	30	3037	0.669	90
Dfhp_seer18	1054	0.280	30	3163	0.839	91
All AC	330	0.103	73	989	0.310	219
All Heat pumps	806	0.149	8	2418	0.447	23

Measure	kWh/kSF	kW/kSF	Therm/kSF
Hi effic gas furn	0	0.000	98
Gas furn plus ECM	356	0.042	91